Smithsonian Institute.

VOL. VI. NOVEMBER, 1882. No. 7.

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THE KANSAS CITY REVIEW OF SCIENCE AND INDUSTRY.

EDITED BY

THEO. S. CASE.

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*Written for the REVIEW.

Subscription Price, $2.50 per Annum, post-paid; Single Numbers, 25 Cents.

For Sale by the AMERICAN NEWS COMPANY, 39 and 41 Chambers Street, N. Y.

Entered at the Post Office at Kansas City, Mo., as second class matter.

KANSAS CITY, MO.
PRESS OF RAMSEY, MILLETT & HUDSON.

WEEKLY OBSERVER,

FALLS CITY, NEBRASKA,

An Independent Anti-Monopoly Journal devoted to the best interests of the whole Country, with Special Departments of Science and Literature

TERMS:—$1.50 a year if paid strictly in advance; $2.00 if not paid within three months. $1.00 for six months, 60 cents for three months, in advance.

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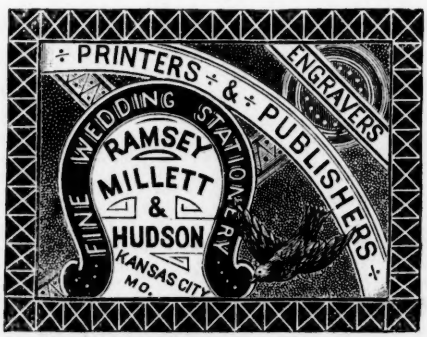

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KANSAS CITY

REVIEW OF SCIENCE AND INDUSTRY,

A MONTHLY RECORD OF PROGRESS IN

SCIENCE, MECHANIC ARTS AND LITERATURE.

VOL. VI. NOVEMBER, 1882. NO. 7.

ASTRONOMY.

THE COMING TRANSIT OF VENUS.

PROF. H. S. S. SMITH, UNIVERSITY OF KANSAS.

The distance between the Earth and Sun is the astronomer's foot rule. With it he measures distances in the solar system and even reaches out and spans the almost endless spaces between the stars. It is, then, of prime importance to him that he know the exact measure of this, his measuring rod.

Ever since the time when Kepler proved and refined the Copernican theory, this problem has been one of the most important and, at the same time, one of the most difficult with which astronomy has had to deal. It has called into exercise the highest powers of mathematical genius, has demanded and obtained, decided improvements in astronomical instruments and methods of observation, and has received more pecuniary aid than any other purely scientific problem.

There are several methods available for the determination of this measure. Among them may be mentioned that by the parallax of Mars and of the minor planets, that by the velocity of light, that by inequalities in the motion of the Moon, and that by the variation of the attraction of the earth on her sister planets. Of these, the first three, in order to be eminently successful, require an accuracy of observation not yet obtained, and the last, while certainly the most reliable of all in its final result, asks for at least five centuries more in which to make a good determination of the distance. In the meantime, the method by observations of

the transit of Venus over the face of the Sun is certainly the most celebrated, and, while lacking some elements of accuracy, and requiring a considerable expenditure of time and money, is a method not to be despised.

Such a transit will take place on the 6th day of next December, and it may be interesting to know beforehand what to expect and when. This phenomenon recurs regularly four times every 243 years, at intervals of 8 years, 105½ years, 8 years, and 121½ years. Here are the dates for four centuries:

1761 . . . . . June 5th.	2004 . . . . . June 8th.
1769 . . . . . June 3rd.	2012 . . . . . June 6th.
1874 . . December 9th.	2117 . . December 11th.
1882 . . December 6th.	2125 . . December 8th.

From this we see that, if the coming transit is not watched, it will be as impossible for one of us to see the phenomenon again as it is to examine the geological structure of the other side of the moon. The next transit will be reserved for the third generation to come.

It is not a difficult matter to understand the outline of the method that deduces the distance between the Earth and Sun from the observations of a transit. Suppose two observers, one at New York and the other at Cape Horn, and each provided with the necessary instruments. Since Venus is between the Sun and the Earth, it is evident that the path of the planet across the Sun's disc, as seen by the observer in New York, will be nearer the southern edge of the Sun, and therefore shorter, than the similar path as seen by the observer at Cape Horn. Knowing the time that it takes Venus to travel each of these apparent paths, the rate with which the planet moves with reference to the Sun, and the apparent size of the Sun, the lengths of these two apparent paths and their distance apart are readily found. All these measurements are, of course, in seconds of arc. Now the distance between the two paths is, also, 2.61 times the distance between New York and Cape Horn, since Venus is 0.723 of the Earth's distance from the Sun. Knowing, then, the length of a certain line on the Sun both in seconds of arc and in miles, the distance between the Sun and the Earth is the immediate result. Previous to 1874 but three transits had been observed, and the results were far from satisfactory. The uncertainty of the result, as estimated at the time, was only nine-tenths of one per cent, and though this amount of error is comparatively small, it really means about 840,000 miles. Combining the results from the transit of Venus in 1874 with the best results from the other methods the probable error is reduced to one tenth of one per cent, but even this small fraction amounts to more than 90,000 miles. This amount of uncertainty will, for instance, produce an uncertainty of 20,000,000 miles in our estimate of the distance of the nearest fixed star. With this comparatively small but essentially great error still connected with the fundamental unit, it behooves the astronomer to improve his methods and make the determination more exact.

In 1874, neither labor nor expense were spared to make the work as thorough as possible. In that year the transit could be seen only from places in the eastern

part of Asia and on the islands of the Southern Pacific, and the expense of fitting out expeditions to go to these distant places was large. Germany alone spent $150,000 on her share of the work. This year the work will be far less expensive because the transit can be seen from all the eastern part of North America and from all of South America, so that it will not be necessary to send out as many parties as in 1874. The observatories already in active operation in this country, South America, Africa and Australia, can be utilized to their full extent. And then the direct outlay will be less because the instruments prepared for the last transit can be utilized for the coming one.

England, France, Germany and the United States have already sent out their expeditions. The English will occupy thirteen stations, viz:—Jamaica, Barbados, Bermuda, Cape Colony (3), Madagascar, Natal, Mauritius, New Zealand, Brisbane, Melbourne and Sydney. France sends out six parties; to Guadelope or Martinique, Cuba, Florida, Coast of Mexico, Rio Negro and Santa Cruz. Germany has chosen four stations; at Hartford, Conn., Aiken, S. C., Bahia Blanca and Punta Arenas.

Parties from the United States will be stationed at the following places: Santa Cruz, Santiago, New Zealand, aud Cape of Good Hope. The principal stations in this country will be Cedar Keys, Fla.; San Antonio, Texas; Fort Thorn, N. M.

The endeavor has been made to choose the places so that the observations to be made may be the most useful in the final solution of the problem. At the same time it has been necessary to take into account the meteorological conditions of the several places and to so arrange the several stations that the probability of unfavorable weather at all the places in any one region may be the least possible. This was done at the International Conference on the approaching transit of Venus held in Paris from the 5th to the 13th of October, 1881. It is of course, necessary that the stations be widely separated from one another in order that the two apparent paths of Venus across the Sun's face may be as far apart as possible and render any small error in the observations as harmless as may be. The work itself is of extreme delicacy. Equal to that, for instance, in the case where a surveyor would be required to find the exact distance of an object six miles away, while not allowed to move his instruments more than three feet in any direction. When such exact work as this is required, it is not strange that particular attention should be paid to the selection of proper stations.

There seems to be considerable difference of opinion among the four nations as regards the best methods of observing the transits. There are three essentially different ways of attacking the problem: 1. By observation of the time of external and internal contacts at ingress and egress; 2. By making direct measures of the distance between the centre of Venus and the edge of the Sun; 3. By photographing Venus and the Sun, and measuring their relative positions afterward.

The English are the advocates of the first method, the Germans of the second, and the Americans of the third. Although the method by contact is apparently

very simple and easy, there are some decided drawbacks to its successful prosecution. It is comparatively easy to determine the time of external contact both when Venus enters and when she leaves the disc of the Sun. But to determine the exact time when the body of the planet has just fully entered the disc, and when it is just about to begin its passage across the edge at egress is an entirely different matter. The dense atmosphere of Venus surrounds the planet with a rim of hazy light and this, with the defraction and irradiation necessary under the circumstances, renders the determination of the exact time of geometrical contact impossible. So great is the effect of these causes that two observers, using similar instruments, and watching side by side, may differ as much as a minute in their estimate of the time of the occurrence. The one redeeming feature of the method is that it requires a difference of two seconds of time to make an error of so much as one-tenth of a second of arc in the measurement, so slow is the motion of Venus across the face of the Sun. And it may be that, by properly training the observers and instructing them carefully about the appearances to be seen, the method may be made to yield satisfactory results. It would seem, then, that the English, with their large outlay, are running considerable risk in trusting entirely to this one method.

The second method is essentially German in its history and use. The instrument—the heliometer,—with which alone the measurements can be satisfactorily made, has done its best work in German hands, and it is but right and natural that they should use it to its full capacity. They do not, however, intend to confine themselves to this one method but will also take observations of the times of contacts.

In the photographic method the observations are made almost entirely by mechanical means and thus the personal equation, that fertile source of discrepancies, is almost entirely obliterated. The instruments required, though expensive and delicate, are not cumbrous, the work itself is not essentially difficult, and there is the decided advantage of a permanent record that can be referred to at any time. It is claimed that the collodion films of the photographic plates are liable to slip and render the record worthless; but, as it seems, this statement has yet to be proved. The principal reason why this method is not to be used more generally at the coming transit is said to be that, because the photographic observations made in 1874 have not yet been completely reduced and their worth fully shown, European astronomers do not wish to try an improved method but prefer to use those whose errors they know. Be this as it may, the results already obtained from a partial discussion of the observations show a probable error far less than those obtained by any of the other processes. May it not be that our cousins of England and Germany are just a little chagrined about the fact that their photographic work of eight years ago was decidedly inferior to that done by the Americans? As the case stands at present, the greatest difficulty in the way of a successful result of the labors of the present year is the lack of harmony between the masters of the science as to best methods of observation. Even if advisable, it is a difficult matter to combine the results found by different

methods, and it may be that this disagreement will render the final determination far less satisfactory than it would have been if the several parties had acted in concert.

While the astronomers are using all the refinements of science to make their observations as accurate as possible, it may be that some people who are not following this special line of work and who, it may be, are not particularly interested in the advancement of science, will find an interest in watching a transaction that cannot occur again before the expiration of one hundred and twenty years. Unfortunately, these random observations cannot be of use in making the final determination of the distance of the Sun more accurate, but there is, nevertheless, a feeling of interest in knowing that one is looking sunward in common with a large part of the civilized world. Adapting the data given in the American Ephemeris to the latitude and longitude of the University Observatory at Lawrence, the times of the four principal phases of the transit are found to be as follows, expressed in Lawrence mean time:

Transit begins	7h.	43m.	A. M.
Internal contact at ingress	8	3	"
Internal contact at egress	1	28	P. M.
Transit ends	1	48	"

We see that it will take Venus about twenty minutes to pass over the edge of the Sun and that more than six hours will elapse between the beginning and ending of the transit. To change these times so as to accommodate them to other localities in Kansas and Missouri, the only difference to be allowed for is that caused by a difference of longitude. Thus: the map gives a difference in longitude of thirty-five minutes of arc between Lawrence and Kansas City, and this means that the phases of the transit will occur a little more than two minutes later by Kansas City mean time than by Lawrence mean time. For those places using the time furnished by the A., T. & S. F. or K. P. Division R. R.'s, it will be sufficient to add fourteen minutes to the times given above.

And now some one may ask how to see it. A person provided with good eyes and a uniformly smoked piece of glass can see the whole transit. Venus will appear as a very small black dot on the surface of the Sun, and will appear to have an exceedingly slow motion from east to west. If, however, a person has a telescope or opera-glass, the observations can be made much more easily and satisfactorily. To the eye end of the telescope, and about a foot from it, fasten a piece of stiff white cardboard nine or ten inches square to serve as a screen. This can be most easily done with pieces of stiff wire tied to the telescope. Then fasten around the object end of the telescope a shield to protect this screen from the direct rays of the Sun. Place the telescope on some convenient rest, point the telescope toward the Sun, and pull out the eye-piece (or lengthen the tube) a little until the image of the Sun on the screen is distinct. With this arrangement half a dozen persons can see the transit at once with comfort and without any danger of injury to the eye. It may be of service to know

that Venus will begin her transit at a point 60° from the south point measured toward the east, and will pass off the Sun at a point 61° from the south point measured toward the west, that is, in the upper half of the southeast and southwest quarters respectively.

UNIVERSITY OF KANSAS, October 10, 1882.

SPECULATIONS ABOUT COMETS.

The present brilliant comet has been the theme of all sorts of speculation, and scientists seem to be at fault equally with the amateur. In fact, as they know nothing definite about comets, those outside the charmed circle may be pardoned if they, too, indulge in speculation.

What seems to us inconsistent in these scientific theories is that, first assuming comets to be composed of the same substance as all other planetary and stellar objects, they disregard the laws of matter. For example, we are told that the comet has passed so near the Sun as to be torn into several fragments that can now be seen with powerful telescopes. On the other hand, the comet of last year, we were advised, was in danger of coming within the attractive sphere of the Sun and convulsing that orb by dropping into it such an addition to its fuel as possibly to burn up our world, or at least be fatal to many forms of life upon it. But this fuel theory has by the same scientists been dissipated by the present comet, which has actually, despite the telescopists, telescoped with the Sun, like two railway trains, and bounded off into space again, minus a few splinters—and even the splinters refusing to fall into the Sun. How are we non-scientific people to gather wisdom from these contradictory hypotheses? Both cannot be true.

As cometary bodies of long periods do not belong to the solar system, it is a question whether they ever really enter it. The Sun's distance from our earth was never known until the parallax was calculated from the transit of Venus in 1761. No cometary parallax is possible and the conjecture that comets enter the solar system at all is not demonstrated. We mean that they never enter the sphere of the attractive force of the solar system. If they did, like asteroids and meteoric matter, they would remain, and from the law of attraction would fall into the Sun did they collide with that orb as the present one is held to have done.

From the very theory of the solar system and the hypothesis that it is but one of a universe of systems of suns and planets, we must conclude that these systems constitute separate spheres of attractive force, and that while they meet, they never commingle—else harmony would be destroyed and chaos reign where order is the first law. Their presence then, as is held, within the attractive force of the solar system is only apparent. The peculiar appearance of comets and the change noted in their aspects can all be explained by the law of optics when we

consider the spheres of different densities that intervene in our solar system between the eye and comet beyond the confines of that system.

We have not the space here to elaborate this hypothesis, and can only suggest it by the statement that a body like that of a comet, when approaching the boundary of its own system, and subject to the attractive force of the solar system, would invariably be an elongated body—the length of its tail being in ratio with its size and the forces operating upon it. Comets must obey and be controlled by the central forces of the system to which they belong, and when they approach near or come in contact with our system, they must from the law referred to, have tails.

The effect of the earth sphere and other spheres of the solar system upon the appearance of a comet must differ with the position of the comet itself. Suppose the sphere of the attractive force of the solar system to be convex. The light projected on this convex surface would be to expand it. But when we view it from the earth, with nothing but the earth sphere between, the effect is that of a convex lens, and the comet will appear smaller and present a more natural appearance than under the other conditions. If dense strata or the sphere of another planet lie between the eye and the comet the appearance will greatly differ, as the comet would then project itself upon the convex surface of that intervening sphere.

The intervention of this sphere as related to the eye of the observer is both concave and convex, and of necessity affects the image seen through it. But even this fact is not all, for we know that the planetary spheres are more dense than the sphere of the system, and light from the comet projected upon such sphere is not so freely transmitted, and will be reflected back upon the outer or parent sphere, which from one point of view is convex—thus presenting to the eye a distorted image of the comet.

Taking these well known facts in optics into consideration, and noting the other fact that in the position of the present comet we see it not only through the sphere of the solar system, but through that of other planetary spheres, the observer may readily be misled to the conclusion that the comet and Sun have been in actual contact, the former appearing by its reflected light to have been so near the latter. But it will be noted that no one observed the comet in conjunction, either inferior or superior, which would have been the case had it been within the solar system, for it was first observed so near to the Sun as to preclude the possibility of its escaping the close search of the astronomers when it was on the other limb of that orb, as it must have been to pass around and come in contact with it. And particularly if it has been broken into so many pieces by the collision it must have been much larger when intact, and more readily observable. And as the tail is in proportion to the size of the nucleus it would have been a much more conspicuous object before than after the catastrophe. These facts can only be explainable upon the hypothesis suggested above. And this can be more readily admitted when we know that the direction of the tail often changes,

and it is lengthened enormously or lost entirely within a few days, which could not be from any other than an optical cause.

Comets, we are told, have been calculated as to their orbits, but we have the additional fact that no return of a calculated comet has ever been known to appear under the same circumstances, a fact that suggests of itself that they are not within the solar system, either in whole or in part, but that it is the position of the bodies composing the solar system and their spheres to that of the observer on the earth that controls the phenomena attending the appearance of comets. In fact, when we consider that comets are without the solar system and obeying the laws of another system entirely beyond ours, about which we cannot know anything, the presumption is very strong that observers mistake comets that come at or within a few years of calcultated periods for the expected return. There can be no certainty, even if we admit that comets do sometimes enter the solar system and leave it again, for in the infinitude of worlds and systems they must traverse on such theory, we cannot discount the forces with which they come in contact to retard or accelerate their motion or deflect them from the imaginary orbits we prescribe for them. At best the whole comet lore of our astronomers is conjectural—guess work and unreliable—and every one is at liberty, as we are, to have a theory of his own.

There is a theory, admitted by all astronomers, which may account for comets, and coincides with the assumption that they are outside the solar system. It is that our system is but one of thousands of suns and their families, all moving around their central body in the same plane. These systems of suns in their circles of motion must frequently come in contact or close conjunction, and the comets belonging to them become visible or approach so near the attractive force of our system as to be influenced in their movements by it. These sister systems may not all be in the advanced state of planetary evolution that we are, and these comets, numbering thousands, be visible thousands of years, as the systems to which they belong and that to which we belong are performing their evolutions.

That the theory we have here outlined has facts to support it we need only refer to the appearance of Halley's comet in 1835. The comet was visible for nine months from the earth. Its first appearance was without a tail for two months, when a tail began to appear, and rapidly developed until it was twenty degrees in length. It then began to shorten, and in twenty days it entirely disappeared. After its "perihelion" it disappeared for two months. On its reappearance it had no vestige of a tail, and the nucleus appeared surrounded by a coma. As the comet receded from the Sun it increased rapidly in dimensions, until in one week it was forty times its size the previous week. It continued to increase until it actually became invisible from expansion, all except the nucleus, which increased in brightness as the envelope dilated and disappeared. At its very last observation it appeared as when first seen—a small round nebula with a bright point in the center. Can any theory so well account for these rapid changes of appearance as the optical one we have alluded to, and which will be

found to be borne out by the position of the planets at the times noted, showing by all analogy that it was the influence of their spheres as related to the position of the earth and the observer upon it that produced the changes in the comet's appearance, and not those of the comet itself.

We might elaborate this beyond the space we have to devote to one article, but enough has been said to show that there is more than one side to this question of comets and to demonstrate that the science of comets, as it is termed, is yet in its infancy, if it can even claim to be that far advanced. Either astronomers are guessing about them or the laws governing our solar system are not so well understood as we have been led to believe. Either the one or the other of these propositions is true, or else comets are but vagrants—emanations amenable to no known law, or optical delusions engendered from the solar system itself—like fogs or wandering clouds in our own atmosphere.

But as we know that nothing else in the universe, that comes within our knowledge, is without purpose and use, and that our system is but a speck in the wondrous structure of the infinite, we must conclude that they have their uses and obey laws as do our planets and their sun, and that our failure to discover their secret is from our own inability to read aright the machinery of the creation, rather than that some mistake has been made in its adjustment, by reason of which these celestial tramps are wandering about responsible to no social law recognized by the heavenly hosts.—*Kansas City Journal, Oct. 22.*

ELECTRICITY AND THE PHENOMENA OF COMETS.

There seems to be a rapidly growing feeling among physicists that both the self light of comets and the phenomena of their tails belong to the order of electrical phenomena. Those who are disposed to believe that the truth lies in this direction differ from each other in the precise modes in which they would apply the known laws of electric action to the phenomena of comets. Broadly the different applications of the principal of electricity which have been suggested group themselves about the common idea that great electric disturbances are set up by the Sun's action in connection with the vaporization of some of the matters of the nucleus, and that the tail is probably matter carried away, possibly in connection with electric discharges, under an electrical influence of repulsion excited by the Sun. This view necessitates the supposition that the Sun is strongly electrified, either negatively or positively, and, further, that in the processes taking place in the comet, either of vaporization or of some other kind, the matter thrown out by the nucleus has become strongly electrified in the same way as the Sun, *i. e.*, negatively if the Sun's electricity is negative, or positively if the Sun's is positive. The enormous disturbances which the spectroscope shows to be always at work in the Sun must be accompanied by electrical changes of equal magnitude, but we know nothing as to how far these are all, or the great majority of them in one direction, so as to cause the Sun to maintain permanently a high electrical state,

whether positive or negative. Unless some such a state of things exists, Sir John Herschel's statement, "that this force cannot be of the nature of electric or magnetic forces," must be accepted, for, as he points out, "the center of gravity (of each particle) would not be affected. The attraction on one of its sides would precisely equal the repulsion on the other." Repulsion of the cometary matter could only take place if this matter, after it has been driven off from the nucleus, and the Sun, have both high electric potentials of the same kind. Further, it is suggested that the luminous jets, streams, halos and envelopes belong to the same order of phenomena as the aurora, the electrical brush and the stratified discharges of exhausted tubes. Views resting more or less on this basis have been put forward by several physicists, and in particular by the late Prof. Zollner, who endeavored to show that on certain assumed data, which appeared to him to be highly probable, the known laws of electricity are fully adequate to explain the phenomena of comets.—*The Nineteenth Century.*

GEOLOGY.

REMOTENESS OF THE FINAL CATASTROPHE.

J. D. PARKER, U. S. A.

Geology teaches that transitions have occurred in the Earth's crust from the earliest geological times. The larger part probably were operative over long periods and effected slow changes in the ocean level, but produced more or less exterminations among living species. Thus in passing from layer to layer in the rocks one or more species became extinct with a corresponding introduction of new species. At the opening of an epoch many new species would appear, and at the commencement of a period a whole fauna. Creations and extinctions have thus been going on through the whole course of geological history.

But at longer intervals greater convulsions have occurred in nature. The course of nature seems at times to have completed a cycle terminating in a catastrophe. A catastrophe (a term which may be retained in geology when properly defined) is not really a retrogression, but a new birth, a more violent transition or unfolding by internal forces, an extermination of life, perhaps an extinction of former races, but an introduction of higher and better forms of life. Such transitions have always resulted in an improved condition of things on the earth, higher and more perfect organizations having sprung into being. Geological history has thus been a *periodical* unfolding from the lower, more elementary and imperfect toward the higher forms of being. Now if nature does not retrograde, or if the law of progress shall remain in force, may we not reason by analogy that in

fullness of time will come the final catastorophe that will introduce an economy of life far transcending all that has preceded it—in a word, the Golden Age of all the Earth's History? Such seems to be general teaching of Science and Revelation.

It is the purpose of this article to show the remoteness in time of this final catastrophe.

Three violent transitions or catastrophes are revealed as having taken place in geological history. The first transpired at the close of the Azoic Age. From a probable state of fusion the earth cooled down, the vaporous atmosphere was precipitated and gathered into seas, in which depositions took place forming sedimentary rocks over immense continental areas. The beds were spread out horizontal, or nearly so, indicating that it was a period of tranquillity. In all the foldings of the Azoic beds there is always a marked conformability of the various strata. But the close of this period of tranquillity was strongly marked in geological history. There was a general upturning of sedimentary rocks, a profound heaving and displacement, a folding, crystallization and metamorphosing, a development of mountain ranges, and a probable extermination of vegetable life. A complete revolution took place, the features of the globe were changed, and a new order of things was introduced over the whole earth. And now followed the ages of mollusks, fishes and coal plants, during which the seas swarmed with life, and the continents were covered with new and higher forms of vegetation.

At the close of Palæozoic time occurred the second violent transition or catastrophe during which there was a very general extermination of existing life. The Earth puts on a new aspect, and there is a new economy of life over the whole globe. The animals of the Reptilian Age far surpass in the scale of being those of preceding ages. Several great Palæozoic races became extinct; palæozoic formations in many regions were folded and crystallized, and prominent mountain ranges were developed. New and higher forms of vegetation sprang into life, and the whole earth put on an improved appearance.

The third and last violent transition or catastrophe occurred at the close of Mesozoic Time when there was again a very general extermination of life. The beds of the Triassic, Jurassic and Cretaceous, the Reptilian Age, seem to have been deposited during a tranquil period, as they are for the most part conformable. True, there were slight elevations and depressions, and evidences of variations in the ocean level resulting from gentle heaving of the Earth's crust, but the the age was one of comparative quietness. But at the close of the Cretaceous Period, there were profound geological movements, a great displacement of earlier rocks, and an extermination of species probably as complete as that closing the palæozoic era. The globe puts on a new garb, and mammals appear, the forerunners of the age of man and of the age of mind.

In the consummation of all things earthly the globe seems now to be awaiting the final catastrophe to usher in the Golden Age. Does science cast any light upon the time when the Earth shall advance through the last transition to new and higher forms of being?

If we take the time-ratios of the rocks we shall find that they point forward like silent indices to a time for the close of this period that is very distant in the future. Adopting the estimates generally employed by geologists, considering that limestones increase with extreme slowness compared with fragmental deposits, not more than one foot of limestone being deposited while five feet of fragmental rocks accumulate, the duration of the Cenozoic, Mesozoic and Palæozoic will probably stand related as 1, 2 and 4. And when we compare the Cenozoic to the Azoic it is lost as a drop in the ocean. But the Cenozoic, or present age, is the most important one in the Earth's history. It is the age of mammals; it is the age of man; it is the age of mind. All preceding ages find in it their development and fulfillment on the earth. It gives significance in our earthly development to all the immense æons of geological history. It is the age that embraces the human period, the crown and glory of the whole creation. Can any species of analogy reduce this age to a comparative insignificance in the time-ratios, while the preceding ages of preparation are drawn out and occupy such immense periods? Rhetorically speaking, is the order of creation anti-climatic? As creation advances to higher and better forms of being, shall things become ephemeral? When everything begins to assume value and importance in creation, when they begin to have real significance, and arrive at a point where we would naturally reason they should have some solidity and permanence, shall we there find that the natural analogical order of creation breaks down, and shall the creation as we find it on the Earth prove a comparative failure? After immense periods, almost infinitudes of time, when we reach the substance of things, shall it suddenly crumble beneath our touch, and disappear to our view? Or shall we not more rationally conclude that the present Age reaches forward to its fair analogical proportions until the human period shall have its natural development and fulfillment, until mankind in all the races, the seething populations of the globe, shall be carried forward, and developed, in a word, redeemed and prepared for the higher and better order of things, the Golden Age of all the Earth's history?

As voices reëchoing in a mighty cañon indicate its amplitude, so there are many voices sounding through the corridors of time which prophesy its immense duration. If we take the coal-fields for example we find fuel stored up in the earth practically in unlimited quantities. But coal is made to burn, was created for the use of man, and it is fair to conclude that man is destined to use it, not in infinitesimal quantities, but the supply and demand are to be somewhat in proportion. The law of supply and demand is more perfectly observed in nature than in human affairs. Now there is one coal-field, the Western Interior Area, covering part of Iowa, Minnesota, Missouri, Kansas, Arkansas and Northern Texas, which would supply all the accumulating population of the globe for a million years. And what shall we say of other coal-fields, many of which in polar regions have not been developed, and of the unlimited areas of coal beneath the ocean much of which will probably in future ages, by the absorption of fluids by the solid portion of the earth, be rendered accessible? Should a man be ten years in erecting a mansion with all the elaboration of modern architec-

ture, and put enough coal in the basement to last half a century, and then deliberately destroy his house the next day, would he be considered a wise man? Will He who made the house in which we live show less wisdom?

There are certain movements in the solar system which by a species of analogical reasoning have left a deep impression on thoughtful minds. The force of this logic is derived from the analogical relation of one part to another or to the whole. In the light of this method of reasoning there is a deep significance in the slow movements of the solar system. The pole of the equinoctial, for example has a slow movement around the pole of the ecliptic completing its orbit in 25,868 years. If we should find a chronometer constructed of an unknown substance with a wheel that made one revolution in a thousand years we would naturally infer that that instrument was intended to run a long time. The Moon in its orbit beats through different forms of the ellipse, requiring according to Professor Mitchell, five or six million years to complete its circuit. If we found another wheel in the chronometer just spoken of which made a revolution in a million years our conception of the time the instrument was intended to run would be proportionately enlarged, and the whole instrument would be judged by the slower movement of the wheel. It is conceded that the whole solar system has a movement in spaces, a movement of great velocity, but carried forward over such immense space that thousands of years elapsed before the best astronomers detected it. Now whatever relates to the solar system as a whole relates to the individual parts, relates of course to the Earth. The argument tends to prove the permanency of the solar system and of the Earth. And this permanency of the Earth resolves itself naturally into immense periods such as we find in geological history. And as the Earth is carried forward with the solar system in its onward movement, made sensible by the apparent opening and closing of stars in opposite portions of the heavens, as these infinitudes of space break over us through which the Earth circles in its onward flight who dare limit the corresponding times during which it makes its passage? Who can set bounds to the present period which gives significance to all these immense cycles of revolution, and for which all foregoing periods have been merely preparatory?

The argument derived from the physical system might be elaborated, but the whole tendency is in the direction of giving a great duration to the present period. The drift of the moral argument is in the same direction. If we take the human period and give it as great an antiquity as we please, and look at the development of the human race we find it only in its infancy. When we speak of the noontide glory of the nineteenth century, our language, stripped of hyperbole, means simply that some portions of the earth are lighter than others. The great masses of populations of the globe still lie in the grossest degradation and darkness. When will the moral regeneration of the populations of the world be accomplished? The difficulties in the way are almost insuperable when we consider the false philosophies, false religions, the spirit of caste, different languages, hostile governments, polygamy and a multitude of social evils, things whose roots have gone way down into the hearts of the nations so deep that it seems almost

impossible to eradicate them. The actual work of regenerating the world as a matter of fact has been wonderfully slow, and missionaries are beginning the work over again in the same places where the gospel was first preached. A railroad can be pushed through a mountain range, but it is difficult to push it over a continent covered with mountain ranges. The mechanical powers seem to be in the infancy of their development. We are just beginning to see the fore-gleams of those things which are to illuminate the world. And yet we have the promise in our sacred books of the Golden Age.

If this argument is met by conflicting interpretations of prophecy we simply answer that prophecy is not read forward but backward. "And now I have told you before it come to pass," says the Great Teacher, "that when it is come to pass ye might believe." It is true that coming events cast their shadows before, for "When the branch of the fig-tree is tender and putteth forth leaves, we know that summer is nigh." To deny that we have fore-gleams of great events would be to deny the very validity of the argument of the present article. But the interpretation of prophecy is the most uncertain portion of hermeneutics. If a day is a year, as many suppose, a thousand years would be three hundred and sixty-five thousand years for the millennium, which probably is nearer the truth. We cannot see how it is possible to reconcile with infinite benevolence the advent of the Son of Man, unless the Logos was incarnated as near the beginning of human history as possible, as soon as all things were ready. We may not be able to measure the distance of a fixed star from the Earth, as the diameter of the Earth's orbit gives no sensible parallax. So the final catastrophe is so remote that the parallax seems to be formed of lines that run out almost parallel through the coming ages. Modern astronomy has revealed to us the immensity of space. Two thousand nebulæ, like our Milky-Way, which contains a hundred million suns with all their mighty trains, probably a thousand million worlds, have been catalogued, and as our telescopes are increased in power new nebulæ keep trooping up out of the misty depths of space. In a similar way geology is revealing to us the immensity of time. As the infinitudes of time break over the student of science, of the present period, he seems to be launched on an almost boundless ocean into which flow the confluent streams of all the past ages. He sees deep currents all around him which bear him onward beneath brighter skies and into fairer climes. In his onward course new constellations arise from the mighty ocean, and a deeper glow tinges the cerulean heavens. He hears inspiring voices by day and voices by night from the sounding sea. All things around him and above him are full of marvels, but that which awes him most is the awful grandeur of the limitless ocean on which he is voyaging, for he hears no waves breaking on the distant shores.

If the argument of this article is well founded this subject has important applications in every-day life:

1. It enlarges our view of the creation, of the importance of man in the divine economy, and exalts our conceptions of the Creator.

2. If the human period is only in fact just begun, if the morning shadows have just fallen on the Earth, we are working on the foundations of human society. In laying foundations we ought to take the greatest care to do our work well.

3. The remoteness of the final catastrophe removes the foundations of belief of a certain religious society who are constantly fixing days for its occurrence. These predictions have failed so often that now they cause more amusement than alarm. Even the ox, which a man in New York has impoverished his family for ten years to fatten, to regale the elect on that occasion, has gone the way of all the Earth. Although the subject is serious we cannot forbear a smile at the homely suggestion of a western stockman who said if that ox must be kept until the final catastrophe, it would be safer to kill him and "jerk the meat."

But however remote the final catastrophe may be, it is always well to remember that the Son of Man cometh to each one of us at an hour we know not, and we should heed his admonition when he says, "Be ye also ready."

ZOOLOGY.

ANIMALS AND THEIR DIET.

Certain facts which have recently come before the public are drawing attention to the question "How did animals first become carnivorous?"—a subject which is the more interesting as it naturally blends with the so-called "Vegetarian" movement. In taking the matter into consideration we must first cast aside two words which enable men to mystify themselves and their fellows. I refer in the first place to the term "carnivorous." This word is sometimes applied to beings which feed on animal matter in general, but it is, perhaps, oftener restricted to such as prey upon the larger animals. Thus some persons would assert that a creature which devours merely worms, snails, insects, etc., is not carnivorous, and in fact zoölogical systematists have given the names Insectivora and Carnivora to two distinct mammalian orders. Others would maintain that an animal which feeds upon the eggs of birds is not on that account carnivorous, since eggs are not flesh. To get rid of all this confusion we must for once "do the thing our soul hates," and propose a new word. Let us call creatures which feed upon animal matter, of whatever kind, zoöphagous. With the vegetable feeders there is a somewhat similar confusion. It is not strictly accurate, *e. g.*, to call a being which lives on fruits or seeds "herbivorous." Hence it is the safest to speak of all animals which feed upon vegetable matter as phytophagous —a term already in use.

This being then understood, we turn to the subject itself. If, as every one must admit, plants came into being upon our globe earlier than animals, then, as

Mr. Allinson contends, the first forms of animal life must have nourished themselves upon vegetable matter. Hence the question when and how animals became zoöphagous is perfectly legitimate.

But at the same time we must recognize that among vertebrate animals, and especially among Mammalia, the earliest forms seem to have been zoöphagous. Among fishes, amphibians, and reptiles, even in the earlier geological epochs, the vegetable feeders are found in a minority. The earliest birds, such as *Archæopteryx*, *Hesperornis*, *Ichthyornis*, and *Apatornis*, which approach nearest to reptiles, and which were probably all armed with teeth—were plainly fitted for a predatory life. Among mammals the lowest and earliest forms are decidedly zoöphagous. This is the case with the monotrematous genera *Echidna* and *Ornithorhynchus*, and also with not a few of the marsupials, both recent and fossil. The oldest of the true placental mammals are the Insectivora, including the hedghog, the shrews, moles, etc. Yet few of these animals partake of vegetable food, save under the pressure of necessity. Nor do they by any means confine their depredations to insects. The hedgehog merits the favoring notice of man as being a destroyer of vipers, but at the same time it excites the wrath of the sporting world by its raids upon the eggs of the pheasant and partridge, and even upon the young birds and upon leverets, and is, for his size, as clearly a beast of prey as is the tiger.

It may even be permissible to ask whether among the mammals the purely phytophagous forms have not been developed from a zoöphagous, or at least from an omnivorous, stock? The only large group which, according to our present knowledge, contains no zoöphagous or omnivorous members, is the old order Ruminantia. Now this sub-order, which is first traced in the Eocene Tertiaries, is characterized by its complicated and highly specialized digestive organs, evidently modified from the normal mammalian type, so as to be adapted to a purely vegetable diet. This same structure, or at least one highly similar, is met with again among the sloths, the only phytophagous section of the Edentata.

The next consideration is that numerous animals which are zoöphagous at one epoch of their life may be phytophagous at another, whether earlier or later. This change is not accidental or compulsory, but ensues naturally and normally in every individual of the species in question. Thus all mammalian animals, whatever may be their future diet, begin life as zoöphagous beings so long as they are nourished on their moth's milk. Indeed it is fully proved that *e. g.*, the human infant is for some time incapable of digesting vegetable matter.

Among birds we meet with the same fact. Setting aside the many groups which are zoöphagous throughout life, we find that, as a rule, the young of the seed- and fruit-eating species require an exclusively animal diet, consisting of insects, worms, etc. In other cases they are fed with half-digested food disgorged from the crop of their parents. There are few, if any, cases where a bird when just hatched is able to feed on crude vegetable matter.

Among insects many similar changes take place. The robber-flies of the genus *Erax*, which in their adult state destroy numbers of hive-bees, feed when

larvæ upon vegetable matter. Not a few butterflies will sip the juices of dead animals, though in their caterpillar stage they are purely phytophagous. The larvæ of the hive-bee are fed upon honey and pollen, without any accompaniment of animal matter. But when mature they may be styled omnivorous, as, in addition to honey and juices of fruits, they are found to lick meat in butcher's shops, and even, according to Fritz Müller, to imbibe excrementitious liquids, as do also the butterflies.

Changes arising from a scarcity of food, or from caprice, are also on record. The two Carnivora which have become domesticated often partake of vegetable matter. The cat is even known to steal raisins and dried plums, and, according to Mr. Bates, in Brazil it goes into the woods to eat the fruit of the Tucuma palm. But amongst wild animals a change of diet, when it occurs, is almost invariably in the opposite direction, *i. e.*, from vegetable to animal matter. Under this head must figure the well-known case of the sheep-eating parrot of New Zealand, the outbreak of cannibalism in an aviary of parrots recorded by Dr. Buller, and the zoöphagous tastes recently developed by baboons in South Africa, who, according to Mrs. Carey-Hobson,[1] sometimes kill and devour sheep. These instances show that the habits of animals are not so fixed as was formerly imagined. They have their preferences, and their digestive organs may be better adapted for one kind of food than for another. But with few exceptions they will not starve, and if what may be called their natural food is wanting, or is scarce, they take any substitute which presents itself. Curiously enough, when any species has thus adopted a new diet, it shows a disinclination to return to its former food.

We have next to consider that the majority of warm-blooded animals are omnivorous, in so far that they consume both animal and vegetable food.

Thus, beginning with the Primates, it is a great mistake to assert that the apes and monkeys are purely vegetarian in their diet. They never omit an opportunity of robbing a bird's nest, and they feed with avidity upon a great variety of insects, from fleas upwards. The lemurs are, if anything, a shade more inclined to animal food than the true monkeys. Even amongst the Carnivora we find not a few which vary their diet more or less with vegetable matter. Thus the bears and their allies, with the exception of the so-called Polar bear, seem to prefer fruits, roots, honey, insects, and even grain before it is quite ripe and hardened. The Viverridæ also include some fruit-eating members, such as the civet-cat. There is no satisfactory evidence that any of the cats in a wild state will consume vegetable matter, but at least two groups of the Canidæ—the foxes and the jackals—are not averse to fruit.

Among the Rodents an omnivorous character is becoming more and more fully established. The squirrels, in addition to fruits, nuts, and grain, greedily devour eggs, nestling birds, and insects; the hamster, the so-called Norwegian rat (Waterton's Hanoverian, but which might be better styled the Russian), even the common mouse, and indeed all the true Muridæ, are omnivorous. We have

1 Knowledge, March 17, 1882.

little doubt but when the habits of the remaining Rodent groups are thoroughly known, it will be found that they all, in addition to their vegetable diet, prey upon insects, worms, and mollusks, if not upon more highly organized animals.

Among bats the majority appear to be purely insectivorous, but the so-called fruit-eating bats—the Pteropidæ or flying-foxes—although provided with a complex stomach and voluminous intestines, feed also upon such small birds and mammals as they can capture.

The Proboscideans, of which the elephants of India and Africa are the sole surviving representatives, are purely phytophagous.

Of the three divisions of the great order of the Ungulata, two—the Solidungula and Ruminantia—are as far as we know, strict vegetarians; but among the Pachydermata we find the swine, which may be regarded as the most typically omnivorous mammals, and the hippopotamus. All the species of swine are eager for animal food. When grubbing in the earth they snap up rats, mice, snakes, insects, etc,, and when opportunity offers they have been known not merely to attack but to devour much larger animals. A horse left tied to a tree, in La Plata, has been known to be killed and eaten by a herd of peccaries. The feral swine of North America have contributed much to the extirpation of the rattlesnake, and the common English pig often contrives to catch and eat up domestic poultry which stray into his sty.

Among the birds we find a very similar state of things. The number of purely phytophagous species is relatively smaller, that of the exclusively zoöphagous larger, and that of the forms recognized as omnivorous is increasing as our knowledge of their habits extends. Who, for instance, would, either from the morphology or from the general propensities of vultures, have predicted what has been observed by Mr. Bates, that these unclean birds devour eagerly the fruit of the pupunha or "peach-palm" (*Gulielmia speciosa*), and "come in quarrelsome flocks to the trees when it is ripe"? The common peacock is called a granivorous and fruit-eating bird; so it is, but at the same time a zealous and efficient destroyer of young death-snakes. Hence the way in which it is shot down by certain blundering sportsmen in India is nothing short of a public calamity. The pheasant is such an eager devourer of wireworms, grasshoppers, and the like, that his extirpation, as threatened by blundering "anti-sportsmen,"—if we may coin the term,—would be a very doubtful benefit to the farmer.

The Merulidæ—the thrush, blackbird, feldfare, and their allies—occasionally evince predatory habits, especially in severe weather. The most purely phytophagous birds are the finches (many of which, however, feed their young upon insects) and the doves.

We now see that the zoöphagous and phytophagous forms of animal life are not separated from each other by any sharply-marked characters, but are connected by a multitude of creatures intermediate in their organizations, and consequently adapted for a mixed diet. We see that animal food is regularly and in considerable proportion, eaten by species not constructed on the typical zoöphag-

ous type as witnessed in the tiger or the polecat. Yet such species, as we may infer from the very fact of their existence, are not thereby injured.

We know that the greatest mass of vegetables, especially the leaves, stalks, and even the roots and the fleshy part of the fruits, are less nutritious than is ordinary animal matter. To this rule the seeds of a number of plants, such as the legumens and the various kinds of grain, form an exception, though even here it would appear that a part of the nitrogenous matter is not present in a state suitable for assimilation. In other words, it exists not entirely in an albuminoid but in an amidic state. Hence we must conclude that an animal which is to exist entirely upon a vegetable diet must have larger digestive organs, so as to operate upon the greatest quantity of matter at once. On the other hand, purely zoöphagous species require, or at least can exist with, a smaller and simpler digestive apparatus. We may go a step further: of all nutriment the poorest—*i. e.*, that which contains the smallest quantity of blood-forming matter—consists of leaves and stalks. Accordingly the Ruminants, which feed upon leaves and stalks, have the largest and most complicated stomachs. In the Solidungula, of which the horse and ass are typical specimens, the diet is the same as that of the Ruminants, but the stomach is simple, and digestion is in consequence far less perfectly performed, as an inspection of the respective excrements of the horse and the ox will readily show. May it not be that we have here the reason why the Solidungula as a sub-order are so far less rich in forms and less widely distributed? We come now to such animals as the swine. Here the divisions of the stomach occurring in the Rumimants are but faintly marked out, to suit a richer diet, composed largely of roots mixed with no inconsiderable proportion of animal matter. A step further we find the apes feeding on fruits and nuts, with the addition of eggs, larvæ, etc. Here the stomach is simple, and the whole digestive apparatus lighter in proportion to the entire body than that of the swine. Lastly, in the true Carnivora, where the diet is most concentrated, we find the digestive canal shortest, and the relative weight of the stomach and its appendages smallest.

Another point of difference between animal and vegetable matters is that the former require less preparation before they can be assimilated. Hence we find that the teeth of the dog or cat, besides their action in seizing and killing the prey, need merely to tear it into lumps of a convenient size for swallowing. When this is once done digestion is not difficult. Vegetable food, on the other hand, requires to be ground to a pulp, so that the saliva and the gastric and pancreatic secretions may act upon its smallest particles. Hence true molar teeth are required, destined not to cut, but to pulverize. We see an approach to this structure even in the bears. But for the poorest kinds of vegetable food this arrangement is not sufficient; the leaves and stalks eaten, consisting as they do largely of cellulose,—which man cannot digest at all,—have to go through that double preparation commonly known as chewing the cud.

We may now venture to assign a reason why it is easier for a phytophagous animal to turn zoöphagous, than for a zoöphagous creature to become phytopha-

gous. A lion, or even an ape or a man, could not take into his stomach so much grass as would afford him sufficient nourishment. Not having the teeth of the ox or the sheep, and not being able to ruminate, he would fail to digest the grass in any degree even approaching to perfection, and he would soon perish from hunger, as not a few men have done who in times of famine have tried to support themselves upon grass and leaves.

But an ape, a rat, or a swine experiences no difficulty in digesting animal food.

Man approaches at least as near—probably nearer—to the pure zoophagous type as do the rodents and the swine. He has three kinds of teeth completely covered with enamel; his digestive apparatus weighs less in proportion to his entire body than does that of the swine, thus pointing to a more concentrated diet. Hence we should be inclined to consider that man is at least as naturally and originally omnivorous as the Rodents or the Suidæ. It has been contended that his "carnivorous practices have not yet changed his nature." Why should they more than has been the case in other omnivorous forms? If sharp nails, projecting canines, and a rough tongue would have given man any advantage in the struggle for existence, doubtless they would have been evolved. But these points do not in the least tell upon his power to assimilate animal matter. His intestine, though of greater relative weight than that of the pure zoophagous species, is evidently required for his present mixed diet, and hence it persists.—*London Journal of Science.*

A LESSON IN COMPARATIVE ZOÖLOGY.

HUBBARD W. MITCHELL, M. D.

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Having entered the wide field of Zoölogy, we see before us a multitude of animals of different forms, sizes, colors and habits. At first view there does not seem to be the least similarity between any two of them. All appear totally different and distinct.

Here the naturalist and the comparative anatomist step in, and begin to study this great mass of animal life, and see upon what plan, if any, it is formed.

He begins by comparison. He compares one frm with another, and sees if any two or more animals have any qualities in common. If so, he assigns them to some order and species, and in this way he simplifies their study.

Let us apply this principle of comparison in practice. Suppose we see together for instance the following:

A Pig, Tapir, Peccary, Elephant 1
A Lion, Tiger, Panther, Cat 2
A Dog, Wolf, Fox, Jackal 3
A Goat, Deer, Ox, Sheep, Camel 4
A Horse, Ass, Zebra 5

How shall we compare them, in order to find feature common to any two or more of them?

Perhaps the feature that strikes us first would be the horns in the ox and the deer. Can we associate these with any of the others?

If we examine the teeth of all the animals in the first, second and third lines, except the elephant, we shall find them sharp and cutting, with long canine or prehensile teeth, admirably adapted for seizing and holding living prey, and for cutting and tearing it. We should, therefore, call these animals carnivorous. If we examined the teeth of the animals in the fourth and fifth lines, we shall see that they have large flat surfaces well adapted to chewing and grinding, and as they live on vegetable substances, we shall call these animals herbivorous.

Comparing still further, we find that in the horse and the ox, both herbivoræ, the horse has incisor teeth in the upper and the lower jaw, while in the ox there are incisors in the lower jaw only, and this arrangement of teeth has a direct relation to the different structures of the stomach in the two animals, the ox having a complicated stomach with four pouches adapted to a mode of digestion by which the food is prepared for a second mode of mastication. This order of animals, those in the fourth line, are called ruminants.

The animals in the fifth line have simple stomachs, and do not ruminate.

If we again compare the ox, this time with the deer, we shall find that while both are herbivorous ruminants, and both have horns, in the ox the horn is hollow and remains firmly attached to the animal's head through life; in the deer it is solid and is shed every year.

Upon looking further we find that the pig, tapir and peccary, carnivorous animals, have a cloven foot like the herbivorous animals in the fourth line, and those last again, are different from the herbivorous animals in the fifth line, which have a solid hoof or foot.

These comparative studies will enable us to classify animals into different orders and species.

Naturalists tell us that certain animals sprang from a common stock, and the differences between them are the results of modifications of structure gradually occurring during long periods of time. Thus the pig has a stout rounded body and a mobile nose. The peccary is a step higher. Then in the tapir, the body is about the same, but the nose is decidedly more developed. The rhinoceros comes in next with the same form of body, and his nose modified and turned upward into one or two horns, and lastly the elephant, with his long mobile nose or trunk, is the highest expression of this common stock.

The order Felidæ, or cats, are almost precisely alike, the differences being chiefly of size, color, and growth of hair. The lion, tiger, panther, leopard, puma, and cat certainly sprang from a common stock, the domestic cat, perhaps, having the highest development, from the fact of its ability to rotate the radius upon the ulna, a motion the larger cats do not have. We see the grace of this motion when our cats play with a mouse or a ball of yarn.

The same fact is seen in the Canidæ, or dogs. They came from a common stock also. The wolf, jackal, dog and fox are of the same species, and have the same structure.

In the Graminivorous Ruminants, the origin from a common stock is apparent. The sheep, with its woolly coat and curved horn, undergoes a slight modification, and we have the goat, also with a curved horn and woolly hair. A further development gives us the deer, and further still the ox. Then comes the camel, and lastly the camelopard, or giraffe.

As an interesting instance of the structure of animals conforming to their modes of life, the giraffe may be mentioned. This animal feeds upon the foliage of trees. Upon his head he has tufted sensitive horns that he may *feel* his food as he passes along. His elongated neck enables him to reach it easily, and in order that he may be on the lookout for his enemies, the crouching lion being his most dreaded enemy, while his head is so high above the ground his eyes are set so that he can see above, below, forwards or behind without moving his head.

The complicated digestive apparatus of ruminants has some relation to their methods of escape from danger. As their food consists principally of vegetable substances, little nutritious and demanded in large quantities, and as they are in turn food for the ferocious carnivorous animals, their only means of safety is in flight, while mastication is a work of time.

They are therefore, obliged to graze rapidly, fill their large stomach reservoir with unchewed food, and then retire to place of safety, where they can remasticate it at leisure.

The horse, ass, zebra and other animals of this order sprang also from a common stock.

We have now seen that by comparing animals with each other we are able to classify them into order and species, each order and species having some distinctive character entitling them to a fixed and permanent place in zoölogical classes.

If now we examine all the forms of animal life on the earth, the fauna, or the animal kingdom, we shall find that they can be comprised under four great heads—namely, Vertebrates, Articulates, Mollusks, Radiates.

It is with the first of these only that this paper will deal.

As we saw that animals were classified under several heads by examining them externally and internally to a limited extent, and this classification gave us Carnivoræ, Herbivoræ, etc., so now if we examine this immense order of Vertebrates by the study of their bony frame-work, or osteology, we shall find that all, from an eel up to man, are constructed upon one single plan.

Beginning with man and descending in the scale, we will briefly examine this bony frame-work, or skeleton, and see what this plan is upon which such a vast part of the animal world has been constructed.

First we find a skull, rounded in shape, hollow, having apertures for the eyes, mouth, etc., jaws set with teeth, and articulated upon the first of a series of bones, or vertebræ. These vertebræ joined together by ligaments so as to form

a continuous column, or backbone, mark the distinctive features of the whole order—viz , Vertebrates.

From the upper part of this spinal column are given off twelve pairs of ribs, which, nearly meeting in front, form a bony cage containing the heart and lungs.

The upper extremities are formed by a scapula and a clavicle, a humerus, radius, ulna, carpus, metacarpus and phalanges.

At the lower end of the spinal column is the pelvis, from which is given off the femur, the tibia and fibula, the tarsus, metatarsus and phalanges to form the lower extremities.

This briefly is man.

In the Simidæ, or monkeys, the facial angle is a little greater, the humerus, the radius and ulna a little longer, the tarsus slightly modified, and in some species the vertebræ are extended into a tail. These are monkeys, modified a little from man.

In the Felidæ and the Canidæ, the facial angle is still greater, the teeth sharp and cutting, with well developed canines, the upright position is changed to a horizontal posture, the upper extremities are now fore limbs, bones modified in shape, species mostly digitigrade. The bears all plantigrade.

General plan same as man.

In the remaining members of the Carnivoræ, as the sea lion, seal and walrus, the fore limbs are modified into paddles, while the hind limbs are less developed. In the walrus the lower incisors and canines are absent, while the upper incisors are elongated into tusks.

General plan same as man.

In the Bovidæ, beginning with the camels and running through the llama, giraffe, ox, bison, yak, goat, zebu, gazelle, gemsbok, sheep, antelope and deer, we have an elongated skull, modified bones of the fore and hind limbs, and a modification also of the carpus and metacarpus, the tarsus and metatarsus, whereby the foot is cloven, owing to consolidation of some of these bones. In some of the members of this order we have the horn, either deciduous or permanent, and in all the cauda. In some, also, we have a longer scapular and longer spinous processes. This affords greater attachments to the nuchal ligaments and muscles for those animals with heavy heads and horns. In the giraffe this is especially noticeable. The shoulders are so high that it makes the fore legs seem higher than the hind legs. This is due to the lengthened scapula and spinous processes. The heads of the femur and humerus are on the same leve.

In all other respects, the general plan is the same as man.

In the Cetacea, as the porpoise, dolphin and whale, the skeleton is the same, except the hind limbs are modified into complete or rudimentary fins.

In the extensive orders of Insectivora, Rodentia, Edentata and Marsupiala, the general plan is that of the higher animals and of man, modified to meet the requirements of its mode of life.

In the enormous class of Aves, or birds, beginning with the robin and ending with the penguin, we have the elongated skull ending in a beak or bill, light

porous bones, an extensive sternum, clavicles united to support the wings, various modifications of the humerus, radius, ulna, and the carpus, metacarpus and the phalanges, as in the bats, etc.

In all the species of birds, the general plan is the same as man.

The same is true of the class Reptilia and Amphibia. In some of the snakes the legs are rudimentary, in others the ribs serve as legs. In the sharks the fins take the place of the fore and hind limbs.

In the class Pisces, or fishes, through the whole series down to the eel, we have the skull, vertebræ and ribs, and the bones of the fore and hind limbs are more or less perfectly represented by the fins. The pelvis in fishes is rudimentary, or wanting.

This brief sketch of the Vertebrata, from man to the lowly eel, shows that the whole sub-kingdom is formed upon a single plan, and that any variations are but simple modifications designed to meet some special requirement. The study of osteology shows us that in this long line of animals—the Vertebrates—the distinctive feature is the spinal column, and it is astonishing, as well as interesting, to observe how little difference there really is between the backbones of any two members of the whole series. The chief differences are in the structure of the head and limbs.

If we compare the anterior limbs of some of the lower animals with the arms of man, we shall see that bone for bone is present, from the humerus to the phalanges. For instance, take the anterior limb of, say, an ape, a bat, a dog, a mole, a deer, a whale, a seal, a tortoise, a fish, or a bird. In each we can distinctly trace the humerus, the radius and ulna, the small bones of the carpus and the metacarpus, and the phalanges.

The differences of shape in each animal are simply modifications of the same bone to adapt it to its individual mode of life.

The intelligence of animals, no doubt, resides in the brain, and it is believed that the amount of the reasoning power, or faculty, is in some way proportioned the quantity of *gray matter* of the brain.

In connection with the reasoning power of animals, depending on brain action, may be mentioned a provision of nature for the safety, which—although it has nothing to do with reason—acts in connection with it.

This is the *mimicry* of animals, or the adaption of the color of an animal to that of surrounding objects in its native wilds.

Nature excites our wonder by her wisdom of this curious and interesting provision.

Thus the tiger, so beautifully decorated with black stripes upon a ground of reddish-yellow fur, tending to white below, living in the long jungle grass of Southern Asia, with the color of which its stripes so closely assimilate, it is impossible for an unpracticed eye to discern it even at a short distance. This mimicry not only protects the animal's satety, but enables it to steal unseen upon its unsuspecting prey.

The uniform dun color of the puma gives it a mimicry for its safety and attack, while crouching upon the branches of trees.

The dark circular spots upon the skin of the leopard give it a mimicry that utterly deceives, as it conceals itself among the leaves of bushes and trees.

The giraffe has, perhaps, the most astonishing mimicry of any animal. Inhabiting as it does the forests of Africa and feeding upon the boughs of trees, its great size makes it a most conspicuous object. Its most dreaded enemies are the stealthy lion and man. In the regions it most frequents are many dead and blasted trunks of trees, and its mimicry is such that the most practiced eye has failed to distinguish a tree trunk from the giraffe, or a giraffe from a tree trunk.

Reliable accounts have reached us where lions have gazed long and earnestly at a motionless giraffe, and being in doubt whether it was a tree or not, have actually turned and skulked away.—*Journal of Comparative Medicine aad Surgery.*

BOTANY.

SOME OF THE WASTES OF NATURE.

REV. L. J. TEMPLIN.

If we take a view of Nature from a utilitarian standpoint, we find that, though exceedingly parsimonious in many things, still in others she is lavishly prodigal and wasteful.

A brief review of some of her wasteful doings may not be without interest to the readers of this Journal. We will draw our first illustration from the vegetable world. The profusion of vegetable organisms seems, from our point of view to be out of all proportion to the uses and needs of the case. Look, for instance, at the wasteful extravagance of plant life on the prairies of North America, the llanos and pampas of South America and the steppes of Northern Asia, where millions of square miles have for inconceivable ages been clothed with a luxuriant growth of grass and other plants, that through all these years have flourished, apparently only to perish and decay. The proportion of these almost limitless productions that serve any apparently useful purpose is so infinitesimally small that it would seem that these profuse productions were only the result of Nature's restless tendency to change.

The same may be said with regard to the vast forests of arboreous productions that have for countless ages covered large portions of the various grand divisions of the earth. But when we take a closer view of Nature's processes in the vegetable kingdom we find this spirit of prodigality carried into her minuter operations in this field. It is a well known fact that in order to the production of mature seed the flower must be fertilized with the fine pollen dust produced

for that purpose. There are three different methods by which this fertilization takes place.

Flowers are composed of two sets of organs—stamens and pistils. These answer to the male and female organs in animals. The stamens produce the pollen that must come in contact with the pistils through which the ovules or rudimentary seeds are reached and fertilized. In the first method by which fertilization takes place both sets of organs are arranged in the same flower. These are termed perfect or hermaphrodite flowers. In some cases the stamens of these flowers are placed in direct contact with the stigma of the pistil so that fertilization takes place by contact; in others the pollen falls or is thrown upon it; while in still others the organs are so arranged with reference to each other that the insects that visit the flowers for their nectar carry the pollen from one flower and deposit it on the pistil of another. But in whatever way this result is brought about there is always a large surplus of pollen produced that answers no useful purpose. Of this class of plants the rose family and most garden plants are examples.

In the second or monœcious class the different organs of the plant are arranged in different flowers on the same plant. Here the pollen must be conveyed from the staminate to the pistillate flowers by the agency of gravitation, winds or insects. In this process of course a very large proportion of the pollen is lost. We have examples of this class in the walnut, squash and corn. In the third and last class, called the dicœcious, the different organs grow upon entirely different plants. The poplars, mulberry and hemp are illustrations of this mode of fertilization. In this case it often happens that the plants bearing the male organs are at a long distance—even some miles—from those that bear the female flowers. Here the agency of winds and insects must be employed in conveying the fertilizing elements from the one to the other. In all these different cases the amount of pollen that is actually employed in fertilizing the flowers of the various plants is but a very small part of all that is produced. In many cases, probably not one-thousandth, if indeed it is above one-millionth part of that which has been produced. Let any one pass through a field of corn at the time the pollen is mostly fallen from the tassels and if it be a dry time he will find the whole surface of the ground literally covered with the shed pollen. Why this great waste? It may be answered that under the circumstances this great surplus is necessary to insure perfect fertilization. But it may be answered that any system that requires such a waste of materials to accomplish the desired end certainly has the appearance of being a very prodigal and imperfect one.

Still another example of wasteful prodigality in the vegetable kingdom is seen in the superfluous amount of seeds that are constantly produced above that which can by any possibility serve any useful purpose. I do not forget, nor would I overlook the fact, that a large part of the grains and seeds annually produced are used for food by man, beast and bird; but aside from this a large proportion of that which is produced from year to year fails to meet any want in either the animal or vegetable kingdom so far as we are able to discover. To impress this fact on the mind let us use a simple illustration. Let us take the

surface of the earth and see how long it will take for the progeny of a single plant to completely cover it with vegetation. The land portion of the earth's surface contains about 47,000,000 square miles. Reduced, this gives us 1,310,284,800,000,000 square feet. Now let us take a plant that will average 500 seeds a year, which is a very low estimate, as many produce several thousands of seeds annually. Now suppose every seed should be preserved and grown for seven years and the product for the last year would be 7,812,500,000,000,000,000 plants, which would be equal to 5,962 for every square foot of land on the earth's surface. But if we estimate the annual increase at only 100-fold, then in nine years the product would give 763 plants to each square foot of surface, which, even at this low estimate, will be seen to be many times as much as could possibly grow on the given space; and this makes no allowance for deserts or barren mountains, which occupy no inconsiderable portion of the earth's surface. This proves that a very large proportion of the annual production of seeds perish without having served any apparently useful purpose in the economy of nature.

In the employment of the forces of nature there seems to be a vast expenditure of energy the utility of which we are unable to discover. A forcible illustration of this waste of energy is found in the force that is constantly employed in lifting the waters of the earth to the aërial regions where they are formed into clouds and afterward precipitated in rain, hail and snow. The amount of water thus lifted up by evaporation to an average height of three and one-half miles is equal to 2,000,000,000 tons per minute. This would be equal to the continued exercise of the combined strength of more than 2,239,000,000,000 horses. Of the vast energy with which this force operates we have an example in some portions of the Indian Ocean, particularly the Bay of Bengal, where at times the evaporation is as much as from twenty to thirty inches in depth over the whole surface in twenty-four hours. Not only is this vast volume of water elevated to this great height but it is conveyed to great distances, frequently hundreds of miles, where it is poured down in rain or snow. It should be remembered that when this vast amount of vapor has been elevated to this great altitude it contains a latent energy equal to that which has been exerted in lifting it to its present position. And in returning to the level of the ocean, as it all does eventually, it gives out this latent energy. Every drop of water that falls gives up in its descent an amount of energy just equivalent to that which was expended in lifting it up to its highest altitude. Every stream that flows is evolving this energy thus stored up in its waters.

This evolution of energy is constantly going on before our eyes in the various rivers that flow by us on their way to their ocean home.

The amount of power that is continually going to waste in the rivers of the Earth is entirely beyond our calculation. Take a single instance—that of the Falls of Niagara, 100,000,000 tons of water plunge over that precipice every hour. Here we have a loss of not less than 56,000 horse-power every minute; about three and a half times the amount of power developed by burning all the coal dug from all the mines in the world. But this great cataract represents

but an infinitesimal part of the energy that is constantly being dissipated by the flowing waters of the rivers of the globe. We may safely admit that a large amount of water is constantly needed to water the earth and cause it to bring forth its various vegetable productions for the use of man and beast, but to assert that the larger part of it is ever so utilized is to claim what is not borne out by the facts before us. We are compelled to admit that a large proportion of the force expended in lifting up the waters that form the clouds and that is given out again in the return of these waters to the ocean, serves no practically useful purpose in the world, but must be set down as a great and useless waste in the economy of nature.

A like waste of energy is in the movements of the waters of the ocean. This vast collection of water is lifted up on its surface, from a few inches in some localities to as much as seventy feet in others, twice in the course of every twenty-four hours. This in mid-ocean is a simple vertical oscillation of the waters through a greater or less space according to the relation of the locality to the position of the Moon. But where it comes in contact with the shores of continents it is greatly modified according to the configuration of the shore line. This variation reaches its maximum in the Bay of Fundy, where the rise and fall often reach from sixty-five to seventy feet.

Where the shore is low the tide flows out over the land till arrested by the higher ground. At the mouths of rivers it enters and flows back until it has reached its level. The rise and fall, the flow and ebb of these tides are attended with an expenditure of force that is beyond all computation. But notwithstanding the immense amount of force involved in the motions of the tides it is almost all uselessly expended so far as appears from a practical standpoint. But the force of waves and currents is not confined to waters of the globe. The great ocean of air that surrounds and envelopes the Earth partakes of like motion and is governed by similar laws. The atmosphere is in almost constant motion. I need not stop here to either prove the fact or to explain the reason. On each side of the Equator for a distance of twenty-five or thirty miles the trade winds blow almost constantly with a velocity of from fifteen to eighteen miles per hour. In other extensive regions there are winds that blow regularly for from six to ten months in the year, while in most other places they are quite variable, but blow from some quarter a considerable part of the time.

Taking it altogether it is probable the winds that blow over the surface of Earth would equal an average of twenty-five miles an hour constantly over one-half of the earth's surface. A wind blowing with this velocity exerts a pressure of about three pounds per square foot. We know only too well the irresistible energy of the cyclone, the tornado and the hurricane. Nearly all this illimitable force is a useless waste so far as appears to the merely practical mind.

The last but not least waste of energy to be noted is that which is constantly emanating from the Sun in the form of light and heat. Careful experiment led Sir John Herschel to the conclusion that the heat of the Sun that falls on the Earth is sufficient to melt 26,000 tons of ice per hour for every square mile.

And it has been estimated by very high authority that if a column of solid ice forty-five miles square and of indefinite length were shot toward the Sun with the velocity of a ray of light, and could all the heat of the Sun be concentrated on the end of that approaching column of ice it would not only melt it but boil it to steam and dissipate it in invisible vapor as fast as it could approach even at the enormous velocity supposed. The amount of heat at the surface of the Sun must be equal to what would be produced by the consumption of not less than 11,600,000,000,000,000 tons of coal every second of time. This is about equal to the consumption of six tons of coal for every square yard of surface per hour. All the coal known to exist in the Earth would suffice to keep up this heat about one-eighth of a second. Now what proportion of this vast energy serves any useful purpose? We know not that any part of it does except that which falls on the Earth. That a large part of this is practically useless is evident from the fact that this is the power that is concerned in the elevation of the vast quantities of water from the Earth's surface noticed above, while much of it falls on deserts and mountains where it is inevitably lost. But suppose all that falls on the surface of the Earth answers some useful purpose, a simple calculation shows that only one part in 2,000,000,000 of the Sun's light and heat falls on this globe. And if we assume that all that is intercepted by all the planets of the solar system is usefully employed it amounts to only 1-227,000,000 part of the whole. All the remainder is waste so far as we are able to see. And it be true that the stars are all suns this waste is to be multiplied by their number and magnitude. From this brief review it appears that in both her materials and forces nature is exceedingly prodigal. True, I have looked at this subject only from a practical, utilitarian standpoint. Had it been viewed from the position of a scientist, a philosopher or a theologian, the conclusion might and probably would have been different. Some of the forces named will doubtless be partially or wholly utilized in the future, but some of them must always remain as apparent examples of dissipation of energy without any compensation.

HUTCHISON, KANSAS.

CORRESPONDENCE.

SCIENCE LETTER FROM PARIS.

PARIS, September 23, 1882.

Paris is a beautiful capital, but it is not at all salubrious; this drawback is due, not to its site, but to its sewerage, though the latter is most remarkable and in many respects fairly provided for. The houses are very substantially built, of excellent stone and iron—wood being expensive and not sufficiently durable—and

on an average are expected to last three centuries. It is only in the edifices constructed within the last quarter of a century, that any attempts to remedy the abominable system of so-called water-closets, have been made. In some hospitals the *latrines* are horrible: no seats, no water to flush, but a hole sunk in the ground the approaches to these dens constituting for the patients a wading through a *cloaca maxima*. In the dwelling houses, the garrets are occupied by the domestics, and the common water-closet is the same receptacle arrangment peculiar to hospitals, railway stations, and several public establishments. Of course there are private water-closets in these places exempt from the foregoing objections. The plan of running off the fœcal matters directly from houses into a street-sewer, may be regarded as unknown in Paris. The Lyons system of emptying the collectors by means of a pneumatic arrangement has just been tried, and found to be impossible, owing to the expense. The *diviseur* plan is the best that exists; cylindrical *tinettes* receive the fœcal matters; a kind of grating apparatus divides or separates the solid from the liquid dejections—the latter being run off into the sewers. At stated periods dustmen replace the full by empty *tinettes* or even barrels; the contents are conveyed to works outside the city—dépôts, mixed with charcoal and other pulverulent substances; then dried, and ground into *poudrette* for which there is a ready sale. The dominating, and old plan, consists of a reservoir in the courtyard, into which the contents of all the water closets flow down an enormous common pipe, which, open at the top, at the roof of the house, acts as a ventilator for the reservoir; the atmosphere of Paris is thus permanently polluted. For successful house and city drainage, the first requisite is a liberal supply of water for flushing the closets, and acting as an extra guard over the piston valve; next, an unvarying flow in the city sewers, as in Brussels, to carry away to a distant out-fall, the fœcal matters. The danger to guard against is, the entry, up sewer or pipes, of the toxical gases or fermentable substances. The latter, according to the delicate experiments of Tyndall, can remain for an indefinite period undecomposed, wherever the air remains stationary.

The blood being life, it is not surprising the extraordinary attention physiologists are at present devoting to its study. Borden described blood as flowing flesh; rolling incessantly through several thousands of channels in the middle of the cells of our organs, the fertilizing torrent brings with it nutritive matters. It is the source of life. Cut a member, electrify it; the muscles will not contract; but if blood be injected by the artery, the muscular contractibility will reappear. Hence the curious experiment of Brown-Sequard, of a dead head on a living body; if the ligature be removed which prevents the flow of blood to the brain the animal will revive. The blood not only brings the nutritive principles to the organs, but it carries away the products of combustion which have become useless for life. Its function becomes interrupted when it cannot obtain the materials of nutrition, in a pure atmosphere and suitable food, and also when the organs destined to carry off the detritus, work imperfectly. Thus all alterations of the organs act on the blood, as the latter re-acts on the organs that it nourishes.

Normally speaking, the blood is rarely primitively diseased; it becomes altered, however, as the materials which produce and feed it, become deranged. Blood has no malady peculiar to itself, but it is the mirror which reflects all diseases of the organs.

Blood is the vehicle of irrigation and excretion; when drawn from a vein it rapidly separates into a white, solid part, the clot or fibrine, and a liquid part, consisting of red and white globules, and the serum itself composed of albumen, salts, and a multitude of organic substances and gas soluble in water. But they are the red globules which attract most attention; they are composed of a kind of white envelope, called globuline, a substance resembling fibrine, and a red coloring matter designated hemaglobine. The mission of this latter substance is to unite with the oxygen of the air when it arrives in the sanguinary vessels of the lungs. The red globules are thus the principal agents of the phenomena of combustion—the process that sustains life. Experiments attest, that the more the globules contain of the red material, the more capable is their *role* of nutrition. Formerly these red globules were counted, to determine the richness of the blood; that process is now superseded by the test of the power of the coloring matter to absorb oxygen. Hitherto bleeding was the grand panacea for all diseases. Botelli laid down, the more water we draw from a well the more that which follows will be pure. This figure was the theory perhaps of Sangrado in *Gil Blas*, who maintained, "one has ever enough of blood to live."

Professor Hayem has demonstrated that blood cannot be taken from the body with impunity; repeated bleedings beget chronic anemia, the blood becomes diluted, the number of red globules diminish, require a long time to reform, and contain less of the important red coloring substance, that is to say, of life. Thus the majority of the organic combustions get weaker; less oxygen is absorbed, less carbonic acid eliminated, fat augments, owing to the work of disassimilation being impeded. At the same time the assimilation of nitrogenous substances by the cells ceases; these substances are destroyed in the nourishing fluids, even without filling the office of nutrition, and the residue, such as urea, augments; hence, gout, rheumatism, diabetes, etc. Similar trouble ensues in the assimilation of phosphoric acid, which forms an integral part of all living cells.

It was once held, that the more blood extracted, the more blood would be re-made; similarly as the more an infant suckled its nurse, the more the milk would be abundant. But there is a limit to the re-formation of the blood. As bleedings weaken the system, if the blood happens to contain any poisonous element, as an infection of purulent nature, the less the constitution can struggle against the disease. However, bleeding is excellent in the case of asphyxia or derangements of the nervous system. Indeed, bleeding is not sufficiently resorted to in the treatment of apoplexy and convulsions as the consequence of accouchment; extracting under such circumstances say seven ounces of blood, acts as a fillip on the circulation. Professor Hayem has obtained very important results from the transfusion of blood, but that process must be supplemented by

iron preparations. Iron exists in our food, in our body, and most largely in the red coloring substance of the blood. Now this coloring matter or hemaglobine and iron, diminish when the number of globules grow less, or even where their state has become altered, though plentiful in point of numbers. This is the case in chlorosis, where the iron in the blood is reduced by one-half. Preparations of iron are naturally administered for this disease, but the efficacy of the medicament does not lie in exciting the functions of nutrition. The iron has an action special in the formation of the red globules, and that action must be sustained by curing the stomach and stimulating nutrition by baths. The globules are not solely composed of iron, but of nitrogenous and fatty substances also, hence why a meat diet, tempered with fatty matters, such as cod-liver oil, favor the regeneration of red globules.

The French Association for the Advancement of Science, has held its meeting this year at Rochelle. The inaugural address was delivered by M. Janssen, director of the Observatory at Meudon. Among other interesting points he stated that it was not Galileo who discovered the first spots on the Sun, but one Fabricius, in 1610. He showed the spots were upon the Sun itself, and not as was then believed, due to the interposition of small planets. Spectral analysis reveals that not only the suns and stars visible to us, but those so distant that the most powerful telescopes are incapable to assign them a sensible diameter; nay more, those nebulæ which appear to the best instruments as only faint rays of light, have been seized by chemistry, by spectral analysis, and shown to be composed of the same matter as our own planets, of the same as we ourselves are formed. Also, that despite the fabulous distances of the nebulæ, chemistry demonstrates that they are subject to the laws of gravitation. When Newton decomposed a ray of white light and thus laid the basis of the theory of the spectre, he little thought his law of gravitation would there find wings to carry it to regions where all measurement ceases and all calculation is powerless.

By spectral analysis and photography, the Sun's atmosphere has no longer mysteries forus; round the central kernel is a luminous envelope—photosphere, formed of incandescent hydrogen, traversed by eruptions of metallic vapors, sodium, magnesium, calcium, etc. This photospere is itself surrounded by another atmosphere, very profound and very rarified. Hurricanes of the most frightful nature occur in the photosphere, which disturb the repose of matter, forming globules of light. The substance of the Sun, as the blood of animals, owes its force then, to globules.

METEOROLOGY.

METEOROLOGICAL FACTORS AND PHENOMENA.

ISAAC P. NOYES.

The Factors which produce our meteorological phenomena are very few, and may, like all other branches of science, be divided and sub-divided into positive and negative, or active and passive. To enumerate them in exact order may be difficult and unimportant.

It matters not whether for the first of our two grand factors we take the Sun or the Earth, for without them both we could not have our peculiar existence or our present meteorological system.

The Sun as the active agent of heat, the generator and sustainer of life, is the active or positive factor, while the Earth is the passive or negative one, yet both are equally important, and in many respects both positive and negative.

But the mere presence of heat or sunshine upon a planetary body will not produce meteorological phenomena. The body must itself be in condition and have certain combinations of elements in order to produce the effect. The heat of a hundred suns concentrated on a non-aqueous body like the Moon would not produce the necessary combinations. In combination with heat we must have water. Such a body as the Moon may, and undoubtedly does have commotions of atmosphere, such as they are, but then all these commotions would not be like those on a body like our earth where water is abundant.

If satellites like the Moon have storms they must be what we would term *dry storms*. The concentrations of heat on certain parts of the Moon must create some disturbance there, but owing to the absence of water whereby an atmosphere is created, the element surrounding the Moon, (ether, if we may so term it—being so subtle and transparent)—though it cause a disturbance, what it may create is not visible to us 240,000 miles away. If there are any storms on the surface of the Moon they must be the result of the movement of dry ether or very light air. There must necessarily be some concentration of heat; some parts of the moon must be hotter than others, and having no moisture to retain heat they must heat and cool rapidly; and it would seem that the points of concentration of heat must change from place to place, at least that the atmosphere, such as it is, of the cooler reverse side must be moved toward those portions where the heat of the Sun is concentrated and that this must establish currents from the cold to the hot and from the hot to the cold.

This idea assumes that the Moon must have an atmosphere, while science

tells us that the Moon has no atmosphere, but it would seem before we decide the point that we must first determine what atmosphere is. It is not necessary that the Moon have an atmosphere like the earth in order to be recognized as having an atmosphere.

But for the presence of water the Earth would have no more atmosphere than the Moon, so atmosphere in the sense as generally understood must be the product of moisture or something resulting therefrom. These remarks about the moon may seem a little of a digression, yet they naturally follow when we come to speak of atmosphere.

In this connection some may wonder why the planets and Moon are not considered as factors in our meteorological economy—for the simple reason that they have not the least bearing in the case and therefore are not factors. Nothing but concentration of heat effects the meteorology of the earth, and only the Sun has power in this direction. There is no heat from the stars, therefore no effect. "How about attraction?" some may ask. The reply to this is, no one who would study the weather-map for a season and see for themselves how storms travel would be apt to put any dependence upon the accidental relative position of the stars or other heavenly bodies than the Sun. The storms come from the development and concentration of the clouds and movement of the atmosphere, and neither the stars, planets, nor even the Moon, have any power over this department. The earth is beholden to the Sun and only to the Sun for its meteorological phenomena; it alone is the major factor—the great positive, active force, while the earth in relation to it is the minor-negative, passive power.

The next great factor, or better, factors, for they are really distinctive and peculiar in their results, is the combinations of motions of the earth in space; its daily motion on its axis—its yearly motion about the Sun, and the gradual oscillating motion of its axis which exposes different parts of the Earth's polar axis more directly to the influence of the Sun.

The daily motion of the Earth on its axis exposing every twenty-four hours the surface of the Earth to the heat of the Sun is the factor of all the daily changes; the yearly motion of the Earth about the Sun is combination with the parallelism of the Earth's axis is the factor of the yearly or season changes. The common notion is that the yearly motion of the Earth about the Sun in the only and sole cause of the changes of the seasons, yet but for what science terms the "parallelism of the Earth's axis" in connection there with these changes would not take place, for the Sun shining perpendicular to the Equator would produce a sameness and no variety—all our months would be alike and the habitable portions of the globe would be much reduced, at least for such organisms as at present flourish upon it.

It is said that we are sometimes nearer to the Sun than at others, but the distance is comparatively so infinitesimal that it amounts to little or nothing, and practically would not be noticed. The third motion, the gradual change in the angle of the inclination of the Earth's axis, the oscillation of the poles, whereby the polar axis describes a circle in the heavens of some 25,000 years, is the factor

of decades or cycles, or the changes which are the result of vast periods of time —producing these, at present, gradual climatic changes which cause the surface of the earth near the poles to be more directly exposed to the rays of the Sun.

These last three factors are the general results of the three motions of the Earth in connection with the heat of the Sun. The third motion of the Earth, however, seems to be very little regarded, yet it is as important as the other two which cause the daily and yearly changes of the seasons. The three motions of the earth are best represented by the spinning top, including the state known as "dying out." It has one (first) motion on its axis; one (the second), along the ground; another (the third) back and forth, which in combination with its rotary motion causes the upper part, which would correspond to the polar axis of the Earth, to describe a circle in the space above it. This third motion of the Earth at present is very gradual, yet there may have been a time when the change was very sudden, and nothing it would seem would so well account for these peculiar and rapid climatic changes of past periods of the Earth's history, when the features of the present torrid zone prevailed as far north as Siberia, and were changed so rapidly as to entomb alive the huge mammoth, nothing it would seem would so well account for this phenomenon as a sudden change in the inclination of the Earth's axis.

The next great factor in our meteorological economy is the concentration of the Sun's rays along certain paths of the Earth's surface. These concentrations are always on general lines from the west toward the east and are termed areas of low barometer—*i. e.*, the heat of the Sun concentrating on certain points produces there a rarification of the air, or would-be vacuum which is the agent to establish a current of air toward this point. The water present on the Earth is a latent factor in the case; it not only provides moisture to immediate surroundings but furnishes the material for clouds which are simply suspended moisture and which are ever ready, when formed, for transportation to wherever the prevailing winds may dictate. The concentration of the Sun's rays producing the area of low-barometer, technically termed "low," is the agent or power that creates the winds.

All these factors, winds, clouds, motion, conditions for existence, all come through that great agent of heat, the Sun. The minor factors though great in themselves, all depend upon are subordinate to the Sun; and it is only when we come to understand the importance of these minor factors that we can by comparison begin to comprehend the greatness of the major factor and the infinite wisdom that established all the beautiful mechanism of our terrestial system.

On the surface of the Earth we have the factors high and low thermometer and high and low barometer. The thermometer we know is the register of the heat, and other things being equal, it will be hottest where the Earth receives the most direct influence from the Sun. The belt comprising the torrid zones is warmer than the temperate, and the temperate warmer than the frigid, and it would seem that there would be no exceptions—it would seem at least in the immediate vicinity of the Equator it should be warmer than half way from there to

the poles. It is *generally* or more extensively warmer as we approach the Equator; notwithstanding this, even as far north as 45° there are points where at times it is full as hot as on the Equator and even more disagreeably hot. General, broad-spread temperature, though a powerful factor in our meteorological system, causing vegetation to grow and the Earth to be fruitful, is not a power for the distribution of heat and productiveness. If heat had no other peculiarity than that indicated by the thermometer the Earth would not support such beings as we much beyond the tropics of Cancer and Capricorn. But the meterological facts of late years have thrown much light upon this department. It has shown to us that what we term the area of "low-barometer," technically called "Low," and caused by the concentration of the Sun's rays, has the power to and does continually travel around the world, on general lines, from the west toward the east. Many people ask, why this is so? Enquiring minds always desire to know the "cause," and it is well they should, but when they will not take the trouble to enquire into the other important causes, in this department, that lead up to and explain this, it does not become them to simply demand the cause of only this prominent phenomenon of meteorology. In all departments of nature we are repeatedly lead up to a *first cause*, every department has its *first cause*, which is established as a fact—a fact that we know as well as we know that the Earth is suspended and moves in space.

What should cause this condition "Low" to obey its peculiar laws? The concentration of the Sun's rays.

What should cause concentration of the Sun's rays, particularly at so great a distance from the Equator, and why should it move as it does? It is easier to explain why it moves, and in other papers (under the "theory of Low") this perhaps has been as satisfactorily explained as it is possible to be. But why the concentration? Some day, with more facts, there may come an explanation; but until then we must accept it as a "first cause." Now that it is so, like many other laws in nature, we can see the beauty of the law establishing it and the wisdom therein; at present it does not seem that we could go further.

The tracks of "Low" (low-barometer) are very eccentric—at times they take directions toward all points of the compass, but as a whole on general lines from the west toward the east or toward the rising Sun. Occasionally, twice this year (1882,) "Low" has retrograded toward the west; this has been during the night. The returning heat in the east the next day soon re-established the current toward the orient. "Low" is the agent of the storm; no "Low"—no storm. "Low" is the centre toward which the wind is drawn; and on its power of concentration depends the force of the winds. People, intelligent people, even those claiming to be meteorologists and writing upon the subject, repeatedly ignore the important factor "Low." An article of this kind recently appeared in one of the leading journals of the country—an article on storms—with not a word about "Low." Hurricanes were produced by the coming together of two currents of wind, a warm and a cold current. Now these two currents cannot come together in any other place or at any other time than when "Low" is passing, or near

the very centre of "Low." As the wind is always toward "Low," it follows that the winds from all quarters must be toward it. North winds which are cold as well as south winds that are hot, and the east and the west winds which combine and partake of the two.

The tornado or the hurricane, call it what you will, for it is all one without regard to name, is the result of "Low" and will always be found in and only in the track of "Low"; and every time "Low" has passed, and is passing over the territory of the United States every three to five days—never regular in time, speed, or direction—always peculiar and irregular in its qualities of concentration, power, speed, spread and direction; every time it passes we are liable to have the fierce storm which we term the tornado or hurricane; and for the reason that it always occurs in the track of "Low" as it passes to the eastward, the Sun being the more powerful in this direction as it not only has the direct power of "Low," but, so to speak, the momentum of "Low" in its course to the eastward. But, it may be said, we sometimes have the tornado with a north wind, which would seem to contradict this; then in the United States it may apparently be so, or locally so, but the power that creates it is the while moving to the eastward. Along the Atlantic sea-board, particularly in the vicinity of Washington, the hurricane will at times occur with a northwest wind for the same general reason that water forming the whirlpool does not travel in a straight line toward the center, if it did there would be no whirlpool. The waters coming with force from every direction act and react upon each other; the result is to establish a circular motion of the currents; so with the winds toward "Low"; they approach "Low" from all points of the compass; their action upon each other establishes a circular motion to the currents. The circle is large, so notwithstanding it may be locally a northwest wind it is really toward the centre, "Low," which has passed the locality to the eastward; and the wind blowing in this manner is what gave rise to the idea that the wind blows, between "High" and "Low," so that if you stand with your right hand toward "Low" and left hand toward "High" the wind will be your face. The wind may in some places be in your face, yet it is all the while seeking the centre "Low"; not in a straight line, but in a grand volute curve.

I may be wrong, but I cannot see wherein the coming together of the so-called warm and cold currents causes the tornado. If the warm and cold currents meet (and they do), they are meeting all the time at the very centre of "Low" and not in the track of "Low" where the tornado takes place; and if they meet all the time it would seem that they should all the time produce the same effect and give us the tornado not only every day but every hour of the day; but we see that they do not—that a great many "Lows" pass over the country without producing a tornado. The tornado occurs late in the afternoon when the Earth has become heated to its maximum point—occurs in warm weather, and seldom if ever in cold, and only with a *high* "Low," or perhaps better, with a "Low" that is traveling on a high line or toward a high line.

August 26, 1881, a hurricane occurred at Charleston, S. C. The "Low"

that caused this storm, at the time not being on a very high line, may seem to oppose this idea, but then it must be remembered that this "Low" came from the south. On the 24th day of August it was reported at St. Thomas. It was therefore at the time seeking a high line, and from present knowledge only under such conditions would it have produced a hurricane in the latitude it did.

A "Low" travelling across the country on the latitude of Charleston I do not think would produce such a storm—it would produce cold, and such a storm requires a vast amount of accumulative force developed by heat which can only be generated, at least in latitudes embracing the United States, by a high "Low" or a "Low" traveling for some distance in a northerly direction.

For years people have been, and are still studying the *effects* of the tornado in its paths of destruction. Many changes are produced, indeed it would be difficult to have a sameness in details, yet with all the general effect is the same every time. There is no light to be obtained by studying the endless variety of detail—it is studying the *effects* and not the *cause*—the cart and not the horse. What we want to study is the cause—the power that creates and not the mere effect that follows. "Low" is the concentration of heat. The tornado is the concentration of that heat to a narrow limit.

A tornado track is never very wide—extended width would prevent its power. Sometimes it is said to be a mile wide, but generally not more than a quarter of a mile or less. For some reason, unknown to us at present, the concentration of the heat is so peculiar as to only effect a narrow track—nature become unbalanced. The tornado is the effort on the part of nature to restore that balance—it is done in the twinkling of an eye. All sorts of plans have been devised whereby to give warning of its occurrence. One might as well during a thunderstorm undertake to give warning of where the lightning will strike. In years to come with more perfect instruments it may be done, but at present it is simply impossible. This is the view of the tornado I would present. Let time prove it or disprove it, it matters not so long as the truth is at least obtained and understood.

In these articles it has been frequently said that "Low" is the agent or factor of the phenomenon, "the storm." Because of this general statement it must not be understood that the phenomenon rain is only the product of the factor "Low"; for meteorology as well as other departments of science has its exceptions, but the exceptions are too often overlooked. Bear in mind that the clouds are all the while being formed everywhere where there is heat and moisture, and that "Low" is simply the agent that gathers them and carries them from point to point to water the Earth. But there are times when the clouds precipitate in the very centre of "High."

This prove that the clounds are being formed everywhere, in "High" as well as in "Low." There are times it is *generally* "High." Under these conditions "Low" is afar off—the clouds the while get heavier and heavier, and when they get sufficiently heavy they precipitate, not waitlng for "Low" to come and take them to other localities.

This summer (1882) "High" has prevailed over a very extensive portion of the United states. The result is pleasant summer weather, and although hot, not oppressively so where "High" has reigned. In the northeast where they have been more under the influence of a *high* "Low" it has been hot and dry. In the neighborhood of Washington it has been a most delightful summer and the foliage has remained bright and green, with few or no vermin to destroy the foliage. So the factor "High" it would seem was not favorable to vermin. The question is do they exist the same as during the protracted presence of a *high* "Low"—are they latent the while, or is it necessary to have the presence of "Low" to generate them? This branch of the subject I respectfully refer to the entomologists.

I have spoken of a *high* "Low" etc., I would specially call the readers attention to these expressions. They may seem paradoxical or ludicrous, but if they will pay a little attention to the subject they will readily see the force of the expressions. A *high* "Low" will be "Low" or low-barometer on a high line of latitude, and as the wind blows toward "Low" it follows that under these conditions we will have the wind from the south and therefore it will be very warm. A *low* "Low" will be in effect the reverse of this. A *high* "High" will be "High" on a high line of latitude, which will prevent the south winds from reaching far to the north, therefore the while it will be relatively cool. "High" over us keeps our locality cool; the south winds do not reach us. A *low* "High" will act as a barrier to the south winds—a *high* "High" as a barrier to the north winds. These factors "High" and "Low" in their variety of changes produce the phenomena daily presented to us. Study them well—keep their motion, speed, spread and direction in mind as they follow each other across the country and we will always be well posted, and as well posted as possible for the human mind to be in regard to the conditions of the atmosphere about us. The weather-map, the all important agent whereby we may understand and keep track of the meteorological phenomena of our country, is, in its present shape, quite impractical to those who are beyond its daily reach. If in lieu of, or auxiliary to this, we could have skeleton maps in every office and even in public places throughout the country, and if people would take the necessary, yet *little trouble* to read them, our Weather Bureau might soon become a far more important and popular institution than it is at present. By making it still more of a necessity to the people it would become more and more popular; and worked upon such a basis would soon wield a powerful influence for good.

Let these skeleton maps be of various sizes, small enough even to appear in the columns of a newspaper, and large enough to hang in public places and be seen and read a number of yards away. Have the map of the United States divided into sections of any convenient size. These sections to be designated by letters or numbers or both. In place of the daily "indications" as at present let the office telegraph all over the country the location of "High" and "Low" in such and such squares and on such and such lines, etc. By daylight in the morning every city, town and village from the Atlantic to the Pacific and from

Mexico to Canada could be informed of the situation—of the meteorological conditions of the whole country.

The intelligent people of the world at least will readily become familiar with "High" and "Low," and it will afford them an infinite amount of satisfaction and be most profitable to them to watch and study the changes of nature, and in many ways be of great practical value to them in forewarning and giving them timely notice of the changes that are to occur—and as it were taking them up into a high mountain and showing them the meteorological conditions of the whole country. It would seem that a plan that could easily accomplish this was worth putting into execution. Let this be done and the Weather Bureau will no longer remain in the background with few to do it reverence. Let it once be thus placed in bold-relief before the public and it will take a new lease of life—indeed its past will be very tame and quiet beside what its future will be. The public will then begin to appreciate the work of this Bureau, and will more readily "lend it a hand" and advocate its claims.

Bear in mind, the weather-map is the *geography of the atmosphere.* By it we have been instructed in the factors and phenomena of meteorology as never before. By it we have been brought face to face with the great revelations of nature. Present this map every morning to the eyes of the whole country in a form suitable for practical purposes and the whole country will comprehend its practical value and sound forth its praise.

Only in a skeleton form can it be made thus valuable and universal. Sooner or later this idea must prevail, and when it does the factors and phenomena of meteorology will be more completely revealed, and through this revelation the world will the better be enabled to comprehend the mysteries of nature in this department and the better understand how to derive practical benefit from its meteorological knowledge.

WASHINGTON, D. C., August 26, 1882.

WEATHER PROGNOSTICS

S. A. MAXWELL.

From time immemorial the people of all countries, savage or civilized, have quoted proverbs in relation to the weather whose origin belonged in the dim and distant past.

Some of these can be traced back, and some of them it seems had more than one origin, if we may use such a paradoxical expression—the same proverb being found current coin in the languages of distinct and widely separated races. When this is the case there must be of course more or less truth connected with it. It is customary to accept these weather proverbs as facts, never looking carefully within to see whether truth or falsehood is clothed with their sober garb. It is probable that more than one-half of the trite sayings in regard to the weather are

utterly without foundation, and if their origin could be traced it would be found the thoughtless utterance of some lunatic or the chance rhyme of a crank who "never had a dozen thoughts in all his life," and who "thinks the visual line that girds him round the world's extreme."

The effort which our Signal Service Bureau is making to collect these proverbs and have them published will clear up this subject to some extent; will doubtless separate the chaff from the wheat, as it were, so that those sayings which have a real value may be made to play a part in perfecting our knowledge of the science of meteorology. It will have little effect, however, on public opinion. Five hundred earnest, educated men may use the most perfect instruments at established stations, and make tri-daily observations of these, record the same, and use many thousand miles of telegraph lines almost constantly, thus mutually assisting one another, and then, the result of their combined labors, under a system the most perfect ever devised, is regarded by millions of our people to be less reliable than the "probabilities" of a medical almanac or the equally valueless prognostication of a weather-prophet, so-called.

But our laborers in the cause of science are producing *some* effect. Public opinion is slowly changing in their favor. The day is distant but is approaching when the people will acknowledge the merits of our Signal Service Bureau and the value of the work accomplished by it.

Some weather proverbs have reference to observed conditions of the atmosphere as, "when there's a fog in the cellar there will be rain;" again,—

> "An evening red the next morning gray
> Are sure signs of a beautiful day."

These sayings have a scientific basis on which to rest, and are therefore to be relied on, while some sayings, I think a majority, originate from some chance rhyme, and are totally unreliable.

We will now trace the causes of some of the phenomena which give rise to weather prognostics.

A fog in the cellar results sometimes, on a very warm morning, when the air is heavily charged with moisture. It is more likely to be observed in cellars where there are openings on opposite sides, permitting a free passage for the air. During the past summer I have noticed a fog in the cellar on two occasions and were followed within twelve hours by severe rainstorms. Brick pavements have been observed to be moist or even wet at mid-day from the condensation of vapor, at times when the air was in a condition closely approaching saturation. This phenomenon, produced by the same cause as the fog in the cellar, will of course indicate a storm in the same manner, or, I might better say it indicates such a condition of the atmosphere as almost invariably precedes a storm. Even the barometer itself does not indicate, when the mercurial column settles, that a storm is approaching a certain locality, but simply that the atmospheric conditions are favorable to the development of storms. On showery days, the bulk of the precipitation occurs in parallel belts from ten to fifty miles in width, sepa-

rated by tracts of greater or less extent where but little or no rain falls; yet the atmospheric conditions are very nearly, or quite the same in both,—the rainy belts and the rainless ones. We may see from this how impossible it is, even with the best instruments, to foretell absolutely what weather will follow even favorable indications of rain. It is not difficult, however, to tell with tolerable accuracy, say five times in six, what the weather will be from one to two days in advance if one observes closely the various phenomena of the winds and clouds in connection with a reliable barometer.

"A rainbow in the morning
Is the sailor's warning;
A rainbow at night
Is the sailor's delight."

There is some solidity in this old saw about the weather, from the fact when a rainbow is seen in the morning it must be in a westerly direction, the one from which storms of the temperate zones most frequently approach. Again, when seen in the east, the bow is formed after the storm has passed, and it is but fair to suppose that pleasant weather will follow. It has also been noticed that the nearer sundown the rainbow is formed, the better the prospect for fair weather. This is because such bows are formed, not after the passage of small, local showers, but of what we term clearing-up storms or those which are of wide extent.

Weather-sayings like those already given, having their basis on certain known physical facts, and being of themselves the simple statement of such facts, can be relied on as true, and when the weather does not accord with them it will generally be found that the failure was due to local or latent causes—such as affect in a greater or less degree the most accurate conclusions of the meteorologist.

In contrast with these is that class of senseless proverbs still passing as current coins of science among the people of even the most enlightened portions of our country,—proverbs originating by accident, and perpetuated in their existence through ignorance, proverbs whose absurdity and unreliability are observed at once by any one who will subject them to the searching light of reason. Among this class of absurdities are the following: "When the Sun sets clear on Friday it will rain before Monday;" "Three frosts and then a rain;" "As the first three days of December be, so will the months of winter be;" "If the woodchuck can see his shadow on Candlemas-day he will go into his burrow and stay six weeks;" "It will be just as many days before a storm as the number of stars within a circle round the moon."

Enough! Ye Gods! What a pity that the authors of these sayings are not known, for if they were, their sacred names might be handed down through the ages, to a remote future, when an appreciative generation would erect to their memory an appropriate monument of donkey-skulls as high as the famous spire at Cologne.

There is not a point in one of this class of weather sayings but may at once

be proven absurd by the weakest process of reasoning, so that an attempt to do so would be like trying to prove an axiom.

There is still another class of weather-proverbs having reference to lunar and and planetary influence whose truth is not as yet positively ascertained. The elder Herschell it is claimed believed that the time of the moon's changing had an effect on climate, but the prevailing opinion now among scientific men is to the contrary. Some years ago I believed that the moon influenced the weather on our planet and set about the task of preparing a paper to prove the same; but the result was, that the investigation of my own meteorological records changed my belief, and I think that with the data I have at hand I can prove conclusively that terrestrial climate is unaffected by lunar or planetary influences.

Some people plant and harvest when the moon is in the right quarter, and think success is assured by so doing, but not one of them can give a good reason, unless it be: "As our fathers did before us so do we." If one would become a reformer of these abuses, would try to enlighten the darkness of those about him who put their trust in the proverbs and practices of a past and superstitious age, he would become discouraged when he discovered the number whose minds like that of Hamlet's mother have been so brazed by custom that they are "proof and bulwark against sense."

MORRISON, ILL., September, 1882.

HAIL AND HAILSTONES.

The immense magnitude of some hailstones, and the intensity of cold during the hottest period of summer requisite to freeze these in their descent to the earth, have never been satisfactorily accounted for. An explanation offered is, that they must have been originally formed at an altitude in the atmosphere where the temperature is greatly below 32°, and that, in consequence of their extreme coldness, they acquired magnitude during their descent by condensing on their respective surfaces the vapors contained in the electrified cloud and atmosphere through which they passed. The difficulty, however, is not altogether obviated by this conjectural explanation. In this country hail-storms seldom assume any remarkable appearance, but in some other countries, especially in the southern districts of France between the Alps and the Pyrenees, hail-storms are so violent, and the hailstones so large as frequently to lay waste large districts of country. Of late years some very disastrous hail-storms have occurred in portions of the western United States and Western Ontario. These storms have invariably been accompanied with thunder and a violent squall or whirlwind. Individual hailstones have been known to weigh as much as five ounces, but there are stories in existence of much heavier ones. These large particles of ice are seldom globular, but rather of an irregular and angular shape. Hail-storms generally occur during the hottest period of the year, and seldom during night or winter.

REPORT FROM OBSERVATIONS TAKEN AT CENTRAL STATION, WASHBURN COLLEGE, TOPEKA, KANSAS.

BY PROF. J. T. LOVEWELL, DIRECTOR.

The usual summary by decades is given below.

TEMPERATURE OF THE AIR.	Sept. 20th to 30th.	Oct. 1st to 10th.	Oct. 10th to 20th.	Mean.
MIN. AND MAX. AVERAGES.				
Min	49.6	55.7	42 9	49.4
Max	73.1	73.1	69.1	71.8
Min. and Max	61.3	64 4	56.0	60.6
Range	23.5	17.4	26.2	22 4
TRI-DAILY OBSERVATIONS.				
7 a. m.	56.5	61.1	47.4	55 0
2 p. m.	73.2	71.1	65.3	69.8
9 p. m.	61.0	61.7	52.4	58.7
Mean	62.9	63 7	54.3	60.3
RELATIVE HUMIDITY.				
7. a. m.	.84	.91	.86	.87
2 p. m.	.64	.65	.51	.60
9 p. m.	.79	.90	.80	.83
Mean	.76	.82	.72	.77
PRESSURE AS OBSERVED.				
7 a. m.	29.10	28.99	28.94	29.01
2 p. m.	29.06	28.97	28.90	28 98
9 p. m.	29.03	28.97	28.91	28.97
Mean	29.06	28.98	28.92	28.99
MILES PER HOUR OF WIND.				
7 a. m.	. .	. .	. .	. .
2 p. m.	. .	. .	. .	. .
9 p. m.	. .	. .	. .	. .
Total miles	3560	3074	3571	10205
CLOUDING BY TENTHS.				
7 a. m.	. .	. .	. .	. .
2 p. m.	. .	. .	. .	. .
9 p. m.	. .	. .	. .	. .
RAIN.				
Inches	.58	1.49	1.52	3.59

CHEMISTRY.

CHEMICAL LITERATURE.

PROF. H. CARRINGTON BOLTON.

[*Extract from an Address Delivered at Montreal, August 23, 1882.*]

* * * * * *

The very earliest information concerning chemical arts comes to us from that ancient nation supposed by some to have given its own name to the science itself; not only do the sculptured tombs and temples of Egypt portray with unimpeachable authenticity and wonderful accuracy the technical skill of that venerable people, but these same monuments are even now relinquishing their hold on long-buried treasures in the form of papyri, whose perplexing script no longer conceals their meaning from the erudition of Egyptologists.

Of these miraculously preserved papyri the most valuable to chemistry is that discovered by Prof. George Ebers at Thebes in 1872, and named after its learned discoverer. We have described this elsewhere and shall not here enter into details. It is the most ancient medical work extant, being assigned to the sixteenth century B. C., and contains a vast amount of information on the medical practice and the pharmaceutical preparations at that remote period. The unknown author wrote less obscurely than many of a much later date, and when the whole papyrus shall have been deciphered it will prove an invaluable contribution to chemical history.

The most ancient manuscript treating exclusively of chemical operations is a Greek papyrus of Egyptian origin preserved in the Library of the University of Leyden. Its authorship is unknown, its date is placed by Reuvens in the third or fourth century A. D. This MS. consists of a collection of prescriptions and receipts for conducting various operations in metallic chemistry, such as the testing of gold and silver; the purification of lead, of tin and of silver; the hardening of tin and of silver; the albification of copper, etc. It deals little with alchemy though some of the receipts evidently refer to transmutations, as those entitled "the preparation (artificial?) of silver;" "the preparation of gold;" "the purification of tin by silver," etc.

Reference is made to sandarach (realgar), cadmia zinc ore), chrysocolla, cinnabar, natron (soda), mercury and other chemical substances, but no receipts are given for their preparation. The author quotes from the Materia Medica of Dioscorides who probably preceded him by about two centuries. It is to be regretted that the full text of this ancient manuscript has never been published; the little known of it foreshadows information of great interest.

The great libraries of Paris, Rome, Venice, Milan, Escurial, Cracow, Gotha, Munich and Cologne preserve a large number of Greek alchemical manuscripts of unknown authorship and uncertain date. Hoefer, the French historian of of chemistry, refers them to the third and fourth centuries, but other authorities with greater probability place them not earlier than the tenth and eleventh.

The most celebrated of these essays are attributed to Zosimus, of whose history nothing is certainly known, and bear these titles: "On Furnaces and Chemical Instruments," "On the Virtue and Composition of Waters," "On the Holy Water," "On the Sacred Art of Making Gold and Silver." In a treatise attributed to Synesius, we find a description of a hydroscopium or hydrometer which was rediscovered as long after as the sixteenth century.

In a treatise attributed to Olympiodorus, he cites as authorities Democritus, Anaximander, Zosimus, Pelagius, and Marie, a certain Jewess whom the later Alchemists confounded with Miriam, Moses' sister.

In these manuscripts chemistry is called the "sacred art" and the exceedingly obscure and figurative language in which they are written, makes it well nigh impossible to separate fact from fancy; Hoefer has indeed attempted to discover modern chemical conceptions in the allusions to Egyptian myths and the chaotic collections of spagyric arcana.

Of systematic nomenclature there is absolutely no trace; indeed each author seems to have aimed to write treatises intelligible only to himself, and we greatly doubt his success in even this respect. "Cadmia," we are informed, "is magnesia," and "magnesia is the female antimony of Macedonia;" "nitre is white sulphur which produces brass;" equally clear is the statement that the "apospermatism of the dragon is the mercury of cinnabar." That lexicons were early in demand is not surprising; in fact some of the most ancient MSS. are "vocabularies of the sacred art," but even with their assistance it is difficult to form satisfactory concepts of contemporary chemical science.

Suidas, a Greek lexicographer of the eleventh century, states that Diocletian having conquered the rebellious Egyptians (296 A. D.) destroyed their books on the preparation of silver and gold, lest becoming rich by the practice of that art they might again resist the Romans. Regrets at the wanton acts of this imperial biblioclast are tempered by the reflection that modern scholars are spared the study of such literary absurdities.

The Chinese, that curious people who always claim a hearing when the origin or antiquity of arts and sciences is under consideration, were acquainted at a very remote period with many branches of chemical technology. We do not know of any special chemical literature produced by them, but the researches of Rev. Joseph Edkins and of Dr. W. A. P. Martin make it highly probable that scholars will yet discover contributions of no small importance to the early history of chemistry. Prof. George Gladstone has endeavored to show that the Chinese originated the doctrines and pursuit of alchemy and communicated it to the Arabians by whom it was disseminated throughout Europe.

The high state of civilization and extraordinary intellectual development of

the Arabians has left a deep impression on chemical science. Cultivated chiefly by physicians, attention was directed to its pharmaceutical applications, and in spite of the prohibitions of the Koran, to the fascinations of alchemy. Of their extant writings, preserved in European libraries, only a portion have been edited; those best known partake of the poetical imagery and hyperbole characteristic of the Oriental mind. This is shown to some extent in the singular titles prefixed to their treatises, *e. g.*, "The Rise of the Moon under the Auspices of Golden Particles," by the alchemist Dschildegi; "A Poem in the Praise of God, of Mahomet and of Alchemy," by Dul-nun-el-Misri.

The well known treatises of Geber, "Of the Investigation of Perfection," "Of the Sum of Perfection," "Of the Invention of Verity," and "Of Furnaces," notwithstanding a bewildering style of composition, which seems to confirm Dr. Johnson's derivation of gibberish. from Geber, display very great familiarity with a large number of chemical substances and operations.

Geber's works are generally assigned to the eighth century and consist chiefly of compilations from the "Books of the Ancients;" he mentions no author by name. They contain chapters devoted to the seven known metals, to the methods of distillation, calcination, cupellation and other operations, to the preparation of saline substances and to chemical philosophy. Geber adopted Aristotle's views of the constitution of matter from four principles, the hot and cold, the wet and dry, and adds thereto: "Mercury and sulphur are the components of metals," a doctrine which with slight modifications prevailed for more than eight centuries. Geber describes the preparation of nitric acid, of aqua regia, and of mercuric oxide; he mentions the increase in weight of metals when calcined with sulphur, and gives the results of a rude quantitative analysis of crude sulphur. He constantly maintains the doctrine of transmutation of metals and gives a refutation of the ingenious arguments opposed thereto. His remarks on the qualifications of a chemist are most intelligent and are not inopportune in modern times; he urges the necessity of diligence, patience, learning, a temperate disposition, slowness to anger, and a full purse, "for this science agrees not well with a man poor and indigent," together with faith in the God who "withholds or gives to whom he will" the secrets of nature, and who will infallibly punish the foolish meddler with magical mysteries.

To detail fully our obligations to Arabian chemists is no part of our plan. They have left an indelible impression on the very language of the science, in the words alcohol, alembic, alkali, borax, and many others. All honor to the intelligent authors who a thousand years ago defined chemistry as the "Science of Combustion, the Science of Weight, the Science of the Balance!"

In the midd'e ages intellectual activity was confined largely to the clergy, who controlled the schools of learning, the libraries, and nearly all sources of knowledge. University chairs were occupied exclusively by clerical professors, literature and science were cast in ecclesiastical moulds. Scientific treatises were the production of monks and emanated from cloisters. Many distinguished philosophers mastered widely separated branches of learning: among these were Alain de

Lille (b. 1114), celebrated as a physician, theologian, poet and historian, who filled the episcopal chair at Auxerre; Roger Bacon (b. 1214) an English cordelier; Raymond Lully (b. 1235), a Franciscan friar, and Albertus Magnus (b. 1193), Bishop of Ratisbon. The latter, amid the monotonous routine of a Dominican monastery, found leisure to distinguish himself in astronomy, medicine, alchemy and, according to his enemies, in necromancy. At this remote period, accusations of dealing with magic were not unfrequently made against those whose learning and skill in experimental sciences excited envy and superstitious zeal.

* * * * * *

Valentine's celebrated "Chariot of Antimony," extolling the medical virtues of this metal, is perhaps the least obscure of his works; the "Twelve Keys of Philosophy" with its singular plates, one of the most unintelligible; yet beneath the extravagant jargon characteristic of the period, glimpses are obtained of light and intelligence. The latter work presents clearly the theory that all metals are compounded of three principles: fixedness, metallicity and volatility, represented respectively by salt, mercury and sulphur, an hypothesis which long completely controlled chemistry until it gave place to the seductive theory of Phlogiston. It is uncertain whether the works ascribed to Valentine were first written in Latin or in German; his writings were collected in the seventeenth century and have been through many editions. Several of his treatises have been translated into English and into French.

In the fifteenth century the newly invented printing press was employed in the production of few works which can be regarded as chemical, and these were chiefly confined to isolated treatises of the ancient philosophers; in the sixteenth century the alchemists began to publish the results of their industry and speculations, and in the succeeding century a prodigious number of alchemical works were issued in Germany, France and England, creating literature of an extraordinary type.

Some of these treatises, which are numbered by thousands, record valuable experiments made by enthusiasts seeking the philosopher's stone, but the majority contain "a crude mass of incoherent propositions and wild assertions, a mixture of poesy and insanity, in which all logical ideas are lost amidst the stilted phraseology, but through which breathed a blind yet fervent faith." Great obscurity of style, an enigmatical method of naming chemical substances which found its highest development in the use of arbitrary symbols and the pictorial representations of alchemical processes, the intimate association with astrology, the honest or affected intermingling of pious comment and prayers, the extravagant claims to interpret the mythology of Egypt and Greece on an alchemical basis; the endeavor to associate the mysteries of Hermes with the sacred truths of the Christian religion, all combine to produce literary monstrosities as fascinating to the student of chemical history as they are profitless to the practical worker in modern science.

Among the fabulous writings, highly esteemed by the credulous alchemists, may be mentioned the celebrated inscription of Hermes Trismegistus upon an

Emerald Tablet, the Golden Leaves of Abraham, Jew Prince, Priest, Levite, Astrologer and Philosopher, which in the hands of Nicholas Flamel yielded such a rich harvest, the Practical Chemistry of Miriam the sister of Moses, and a multitude of grotesque writings ascribed to personages of known reputation. Raymond Lully is credited with five hundred works; Hermes Trismegistus, the mythical Father of Sciences, with several thousand.

THE EXTRACTION OF THE PRECIOUS METALS FROM ORES BY ELECTROLYSIS.

Mm. Blas and Miest have discovered that if in electrolysis we replace the metal of the anode by compressed sulphur-ores these may themselves serve as an anode. Further, if we place such anodes in a bath of a suitable electrolytic salt having the same metallic base as the metal of the ore, and if we let the electric current act in such a bath, the effect is that all the sulphur of the ore is precipitated upon the anode and falls to the bottom of the bath. At the same time there is formed at the cathode a precipitate or continous deposit of metal liberated from the salt of which the electrolytic bath consists. The acid of the bath being set free appropriates an equivalent proportion of the metal contained in the ore placed at the anode. In this manner the neutral electrolytic bath is re-constituted without ceasing and serves indefinitely.

ELECTROLYSIS OF VARIOUS SULPHURETTED ORES. For simple sulphides, without gangue, containing only sulphur and a single metal, is exceedingly easy and complete. If we have an electrolytic bath containing a soluble salt of the same base, *e. g.*, a bath of lead nitrate, in case of the treatment of pure galena, this ore is placed at the anode, when under the action of the electric current the sulphur is deposited at the anode and the lead at the cathode. If the ore contains in addition to the metal a silicious gangue, the silica is deposited at the anode at the same time with the sulphur. But these two substances though mixed together remain distinct. They fall in part to the bottom of the bath, and it is advisable to remove the rest from the anodes by an automatic brushing.

If there are antimony and arsenic in the ore, which are also precipitated at the anode, but chiefly in the state of insoluble oxides, mixed, but not combined together, nothing is easier than to separate them again by electrolysis.

In case of ores containing exceptionally much arsenic, a part of this during precipitation at the anode combines with sulphur, producing arsenic bisulphide or realgar and the yellow sulphide or orpiment.

These products are extracted and purified at first by sulphuret of carbon and afterwards by separate electrolysis in a bath with a feeble electric current, when they yield pure sulphur at the anode and oxides of arsenic and antimony at the cathode.

If we operate electrolytically on sulphides containing several metals, those

of the precious metals contained in the sulphur ores, being the most easily precipitated, are thrown down first in the metallic state at the cathode, under the action of a moderate current, and consequently the electrolytic bath is regenerated without ceasing. There is merely one further operation, that of separating afterwards those of the metals which have been thrown down together at the cathode. But this final separation requires very little electric force, because this mass of metals, already previously reduced to the metallic state and purified, when they are placed together in another electrolytic bath and are dissolved there under the action of the electric current, regenerate the thermic force or thermic work necessary for the ulterior precipitation of each metal separately, saving the slight unimportant and inevitable losses of thermic or electric action.

We extract first the sulphur of carbon disulphide used, with or without pressure. Carbon disulphide dissolves and removes promptly that part of the mixed sulphur which is combined neither with silica nor iron.

On re-distilling the decanted carbon disulphide loaded with dissolved sulphur, the latter is deposited in a state of purity.

If the electrolysed ore is a multiple sulphide, containing especially much iron, we obtain then at the first operation sulphur and iron oxide. If in place of then separating these two bodies by one of the methods descsibed above, we electrolyse them feebly a second time in a bath composed *e. g.*, of dilute sulphuric acid, we obtain then pure sulphur at the anode, and iron as a basic sulphate at the cathode. But sulphate of iron is in regular demand and of great use in industry. We may otherwise electrolyse it again or use it as an electrolytic salt for the extraction of iron.

In separating the mixture of sulphur and iron oxide there is no outlay of work or of thermic power. On the contrary, in this operation there is production of heat, and consequently of work.

Practically, one and a half horse-power is required to produce electrolytically in one hour one kilogramme of copper set free from a sulphuretted copper ore, a wonderful result in point of economy.—*Les Mondes.*

PHYSICS.

TELEGRAPHING WITHOUT WIRES.

At the British Association meetings at Southampton, Mr. W. H. Preece, electrician at the General Post Office, adverted, in a paper on "Telephones," to an experiment he had made of telegraphing from the mainland to the Isle of Wight without employing a cable across the intervening space of water. This he accomplished by utilizing the property of electricity named induction. The efficiency of the telephone is frequently interfered with by currents of electricity

being "induced" in the telephone wire by the electricity in telegraph wires, and Mr. Preece conceived the idea that as induction takes place sometimes in wires which are several miles apart, use might be made of this property to dispense with wires in certain cases. The purpose of wires is to carry the electric current, but if the current were ready to travel of its own accord without wires the saving in maintaining telegraphic communications would be very great.

This idea, however, is not a novel one. At the meeting of the British Association, held in Aberdeen, in 1859, the late Mr. J. B. Lindsay, of Dundee, read a paper, in which he described experiments almost as extensive and precisely the same in their method as that explained by Mr. Preece at Southampton the other day. In the days when our achievements with electricity are deemed so considerable, the humbler efforts of Mr. Lindsay are apt to be forgotten. There is no doubt, however, that he foresaw much that has only been accomplished within the last few years. His inventive faculty was keen, and he possessed the energy and perseverance, though unfortunately not always the resources, to work out his inventions. His studious disposition was remarkable, and if his talents had been developed in a sphere more suitable for them than the banks of the Tay, his name might have become famous in the annals of science. His prescience is exhibited in the following paragraph, which is taken from the *Dundee Advertiser* of August 7, 1835. It describes all the virtues of the electric light with as great completeness as though it had been written of a discovery by Edison or Swan:

"Mr. Lindsay, a teacher in town, formerly a lecturer to the Watt Institution, succeeded, on the evening of Saturday, the 25th ult., in obtaining a constant electric light. It is upward of two years since he turned his attention to the subject, but much of that time has been devoted to other vocations. The light, in beauty, surpasses all others, has no smell, emits no smoke, is incapable of explosion, and not requiring air, can be kept in sealed glass jars. It ignites without the aid of a taper, and seems peculiarly adapted for flax houses, spinning mills, and other places containing combustible materials. It can be sent to any convenient distance, and the apparatus for producing it may be contained in a common chest."

In 1836, Mr. Lindsay lectured on the electric light, and stated that as early as 1831 he had turned his attention to the subject. In a letter published by him in 1845 he suggested the possibility of laying an electric cable across the Atlantic, a dozen years before the project was seriously entertained. Afterward he developed a scheme for telegraphing across oceans without cables. He lectured at Glasgow, in 1853, on his theory of forming an electric communication between Great Britain and other countries without the employment of submarine wires, and the cost of such communication to America he calculated to be £60,000. A patent for his scheme was taken out in 1854, and several experiments were made by him at different places. The following paragraph appeared in the *Dundee Advertiser* of May 20, 1859:

"ELECTRIC TELEGRAPHING ACROSS THE TAY WITHOUT WIRES.—We have received the following note from Mr. J. B. Lindsay, reporting progress with his

experiments. The results, it will be seen, are highly encouraging: 'Yesterday, May 17th, I telegraphed successfully across the Tay, opposite to Glencarse, where it is about half a mile broad. The action on the needle was strong, and the same battery power would cross, I think, at Broughty Ferry.'"

The dock authorities at Liverpool invited him to exhibit his invention on the Mersey, but owing to his apparatus having been deranged, his experiment in England was not successful. This caused skepticism as to the merits of the discovery, and he made renewed tests with it on an extended scale on the Tay. These fully realized his expectations. The *Dundee Advertiser* of July 10, 1860, contained a letter to the editor, in which Mr. Lindsay wrote:

"During last week I was engaged in making a telegraphic experiment across the Tay below the Earn, at a place where the river is more than a mile broad. The experiment was successful, and the needle was strongly moved, but, as I had no person with me capable of sending or reading a message, it was not attempted."

Meanwhile he had exhibited his scheme to the *savants* of the British Association at the meeting in Aberdeen in 1859. Experiments were made with it across the river Dee, and he read a paper describing its theory to the Mathematical Section, in the debate on which Lord Rosse, chairman of the section, and other leading scientists took part. Before quoting the condensed report of this paper, it may be well to quote the passage in Mr. Preece's paper on "Telephones," read at Southampton last week, in which he adverts to an experiment exactly on the lines of Mr. Lindsay's scheme:

"Mr. Preece had recently tried an extremely interesting experiment between this place (Southampton) and the Isle of Wight—namely, to communicate across seas and channels without the aid of wires at all. Large metal plates were immersed in the sea at opposite ends of the Solent—namely, at Portsmouth and Ryde, six miles apart, and at Hurst Castle and Sconce Point, one mile apart. The Portsmouth and Hurst Castle plates were connected by a wire passing through Southampton, and the Ryde and Sconce Point plates by a wire through Newport; the circuit was completed by the sea, and signals were passed easily so as to read by the Morse system, but speech was not practicable with the telephone."

The following is the report of the paper on "Telegraphing without Wires," read by Mr. J. B. Lindsay to the Mathematical Section of the British Association, at its meeting in Aberdeen, in September, 1859, which appeared in the *Dundee Advertiser*. After relating various minor experiments, he proceeded to describe his process, saying:

"Recently he had made additional experiments, and succeeded in crossing the Tay where it was three-quarters of a mile broad. His method had always been to immerse two plates or sheets of metal on the one side, and connect them by a wire passing through a coil to move a needle, and to have on the other side two sheets similarly connected, and nearly opposite the two former. Experiments had shown that only a fractional part of the electricity generated goes across, and that the quantity that thus goes across can be increased in four ways: First—by an

increased battery power; Second—by increasing the surface of the immersed sheet; Third—by increasing the coil that moves the receiving needle; and Fourth—by increasing the lateral distance. In cases where lateral distance could be got he recommended increasing it, as by that means a smaller battery was requisite. In telegraphing by this method to Ireland or France, abundance of lateral distance could be got, but for America the lateral distance in Britain was much less than the distance across. In the greater part of his experiments the distance at the side had been double the distance across; but in the experiments in the Tay the lateral distance was the smaller, being only about half a mile, while the distance across was three-quarters of a mile. Of the four elements above mentioned, he thought that if any one were doubled the quantity of electricity that crossed would also be doubled; and if all the elements were doubled the quantity transmitted would be eight times as great. In the experiment across the Tay the battery was of four square feet of zinc, the immersed sheets contained about ninety square feet, the weight of the copper coil was about six pounds; the lateral distance was less than the transverse distance, but if it had been a mile, and the distance across also a mile, the signal would no doubt have been equally distinct. Should the above law (when the lateral distance is equal to the transverse) be found correct, the undermentioned table might then be formed.

"But supposing the lateral distance to be only half the transverse, then the distance crossed might be 16,000 miles, and if it was only a fourth, then there would be 8,000 miles, and thus a greater distance than the breadth of the Atlantic. Further experiments were, however, necessary to determine the law. Since last experiment he had increased the coil, and thought there was power to come two miles. According to this calculation, he thought a battery of 130 square feet, immersed sheets of 3,000 square feet, a coil of 200 pounds weight were sufficient to cross the Atlantic with the lateral distance that could be obtained in Great Britain."

The following is the table above referred to:

ZINC FOR BATTERY.	IMMERSED SHEETS.	COIL.	DISTANCE CROSSED.
4 sq. ft.	90 sq. ft.	6 lb.	1 mile.
8 "	180 "	12 "	8 "
16 "	360 "	24 "	64 "
32 "	720 "	48 "	512 "
64 "	1,440 "	96 "	4,096 "
128 "	2,880 "	192 "	32,768 "

If Mr. Lindsay's hopes are to be realized, some great discovery yet remains to be made, for, by the laying of the Atlantic telegraph cables, we know that the electric current, transmitted across the wide expanse of the Atlantic, must be of extraordinary power to be apparent on the other side, even with a cable to lead it. Without a cable it would be hopeless to expect to find it, although the best apparatus were employed. Telegraphic instruments are greatly improved since Mr. Lind-

say worked with them, and as regards batteries and coils he would find available for his purpose all that he could wish. No currents, however, are in use which would induce another current 2,000 or 3,000 miles away. Still it is within possibility that such may be found, and to a Dundonian must be ascribed the honor of having first conceived the scheme of transoceanic telegraph communication without the aid of cables.—*Dundee Advertiser.*

ARCHÆOLOGY.

AZTEC REMAINS IN LA PLATA COUNTY, COLO.

At the Denver Exposition there were exhibited some Aztec remains from Farmington, La Plata County, Colo., of intense interest to the student. They were found in the ruins of a building several stories high, which had been erected in the form of a terraced pyramid, near the mouth of the Animas River.

Nearly all the bones of the human body were discovered in a good state of preservation. Among them were three skulls, two of men and one of a woman. The latter was also young, as the distinctness of the suture joints testify; one of the male skulls was of a middle-aged person, and the other evidently of an old man as the several parts had grown almost solid. All were very thick, showing characteristics of the semi-barbaric races. The teeth remaining were mostly sound, though one showed marks of an ulceration, and there were several empty sockets.

Besides, there were some fine specimens of Aztec pottery of perfect color, parchment, stone implements, etc., from the same vicinity. This section of Colorado has been as yet little explored, but enough has been found to demonstrate that it is a region of great value to archæology. F. E. S.

HUMAN FOOT-PRINTS FOUND IN SOLID ROCK.

The Nevada State's Prison, at Carson, is situated on a sand-stone spur, which runs out from the Pine Nut Mountains into the Carson Plains, like a great promontory. The prison quarry has uncapped the spur to a depth of from thirty to forty feet, and exposed a layer of arenaceous shale. In this shale, and covering a space of about an acre and a half, have been found a large number of tracks, both of animals and birds, and what are supposed, also, to be human foot-prints. Eight great square impressions, twenty by twenty-two inches in size, showing stride of four and a half feet, come out from the super-incumbent rock. These have been supposed to be the tracks of a mastodon, or mammoth. Tracks of a wading bird are also seen along with it. What is more remarkable, however, is

that a number of foot prints, such as a giant man would make, if shod with thick-soled moccasins or sandals, have been found. There are six series of them, the foot-prints numbering from eight to seventeen inches in each. The size of the sandal is as follows: nineteen inches in length, eight inches broad at the ball, six inches at the heel, having a length of stride two feet three inches. The distance between the feet, or straddle, is eighteen inches. Most of them have straight-pointed toes, supposed to distinguish the white man of to-day. In no case is the naked foot distinctly shown. In all the tracks the toes turn outward.

This discovery, with that of the Calaveras skull, will, no doubt, be seized upon as direct proof that man existed in the Tertiary, as early as the Miocene. From these papers it appears that several quite distinct tracks of deer are to be seen, some which resemble those of a wolf, and abundant tracks of wading birds, which do not differ from those of the same class now living. The rock above the tracks is fifteen feet in height, and gives evidence of having been at one time the shore of a local or isolated lake. Its level is above that of Lake La Hontan, which itself is, as is well known, an ancient basin, now empty, but was, in the Pliocene age, the bed of a great lake or fresh-water sea. These tracks antedate the present river-system of the Sierras, and must be very old. It seems to be uncertain whether the rock belonged to the Quarternary or Tertiary, but it is more uncertain whether they are human foot-prints or not. Papers were read before the California Academy of Science by Dr. Harkness and Mr. Gibbs, both of whom seemed to think that the tracks are doubtless human.—*American Antiquarian.*

PHILOSOPHY.

THE ORIGIN OF MATTER AND THE INDESTRUCTIBILITY OF MIND.

WILLIAM STEVENS.

At present there are and have been for innumerable cycles of ages two great forces in the Universe. One Superior, the great moral force self-existent and eternal, and the Inferior, physical force emanating from the great moral force. All the mental and moral powers in the Universe have had their origin in this great moral force, and are governed, directed and controlled by that great force, while the physical forces are rules of action or laws of matter also, an emanation from the great moral force and to which their author set bounds at their origin for the production, government, direction and control of matter throughout the universe; nor does either act except in its appropriate sphere and each as distinct during all these long ages as if the other did not exist. To say the physical forces were not perfect and would need revision or supervision would be to im-

peach the power and wisdom of the great moral force. These physical forces are not matter, are not mind, but are laws enacted by the great force to prepare a place for the culture, increase and expansion of mental and moral power to inhabit, the moral Universe, which is destined to take the place of the material Universe. The physical forces having had a beginning will necessarily have an ending and when the laws which originated, governed, directed and controlled matter cease, matter must of necessity cease and become entirely extinct and the great moral Universe, be inaugurated and naught will exist in that Universe but mental and moral power. Then that vast amount of mind which has been in a preparatory and tutelary state in the material Universe will be transplanted into the great moral Universe to enter on a new state of existence running parallel with eternity, increasing and expanding as the cycles of eternity roll on.

In the incomprehensible eternity of the past there must have been a fragmentary part of that eternity when there were no physical forces and consequently no matter—nothing but the great moral force. To argue against this hypothesis is to claim the physical force, the inferior and the creature, the equal of the superior and creator, the great moral and eternal, which is to maintain the eternity of matter, as the physical forces could not have existed without producing matter governing, directing and controlling it.

How long these physical forces have existed, or how long they will exist, is a secret in the bosom of the great moral force, and can be, under the present lights of science, but a matter of conjecture, and as philosophy does not deal in conjecture we will not attempt to discuss a subject which has no data from which to reason.

Is it insisted that these are assumptions without any authority to sustain them? We reply they have a basis as broad as the verdict of the advanced thought upon the improvements, discoveries and advancement in scientific knowledge. We are sustained by the cultured and educated mind, the world over, where science is made a study and particularly by the savants, scientists, matheticians and chemists, that matter is exclusively governed, directed and controlled by fixed laws, the physical forces.

The astronomer, familiar with the heavenly bodies and with the physical forces governing, directing and controlling those bodies, can foretell centuries in advance with absolute mathematical precision the very moment when an eclipse of the Sun or Moon will begin or go off, when a comet that has not been seen for half a century will make its appearance and when it will take its departure, as well as other phenomena which are occasionally taking place in the heavens. The chemist in his laboratory, from his knowledge of affinities and certain of the physical forces, can make compounds with the most implicit confidence as to the result. While in another branch of science the age of our planet has been told probably with some accuracy, but from the fact that the science in which they have made their discoveries and from which they have drawn their data is yet in its infancy conclusions are not satisfactory, but vary from two hundred millions of years up to six hundred millions—sooner or later more diligent and accurate re-

search will enable them to closely approximate its actual age. This then will fix the date and age of the physical forces, as the age of our part of the planetary system is about the age of the other planets, the Sun preceding them as they were doubtles fragments of the Sun thrown off at different times, while the satellites of the different planets are parts of their respective planets and are younger.

But again the mathematicians have weighed the planets and by calculation located undiscovered planets and satellites where the physical forces required they should be to keep the different bodies in their orbits directed astronomers to turn their telescopes into that portion of the heavens and who found them as located. Here is proof positive of government, direction and control of the physical forces. But the age of the globe will fix the age of the physical forces, as they could not have existed in that portion of space occupied by our system for any considerable space of time without producing the matter of which the system is composed, nor could our system have existed at its origin without these laws any more than it could to-day, and without them now there would be an immediate "wreck of matter and a crush of worlds." All the different laws governing matter are as inflexible and as exact as mathematics and chemistry and they will be so regarded by the learned as soon as they shall be as well understood and will remain as unchangeable as their Author throughout until their appointed time comes when they will die and with them matter and time. But it is said matter is indestructible and so says philosophy, that is, however, during the existence of those laws that gave it birth and govern it. For during the existence of the physical forces as fast as matter in one form dissolves the physical forces take up the elements of which it was composed and clothe it in new forms. But when there are no physical forces to take care of those elements they too will dissolve with the form they composed, and death and not mutation will be written upon every form of matter.

There is now, has been and will continue to be in the material world so long as that material world shall remain an inconceivable amount of minor, mental and moral forces, emanations from the great moral force and governed, directed and controlled by this force, and over which the physical forces have no influence, no power, no control, no direction, except incidentally and as the moral and mental symphatise with the material as it may be brought under the influence of and subjected to the physical forces.

But man has assumed that he is the highest order of intelligence in the material Universe and being at the head of the animal kingdom he alone will inherit the future domain of mind, intelligence and moral force. That he is at the head of the animal kingdom and the highest order of intelligence in the material Universe is the merest assumption, with no authority in reason or nature and without any proof to sustain it. While it is not denied that on this very minute portion called the globe he occupies that position, but as to what orders of mind, intelligence and moral forces exist in other portions of the physical worlds may be regarded as too uncertain for even conjecture, yet it must be considered that somewhere in the material Universe there is a very high order of mental and moral force in the

shape of beasts, higher than any known to this little mundane sphere. If not, from whence came the "four beasts in the midst of the throne and around about the throne of God who fell down with the four-and-twenty elders and worshipped the lamb."

He further assumes that the inferior order of organisms, governed, directed and moved in all their actions by what he is pleased to call instinct, must forever perish and never exist in any form whatever in the great hereafter. And that too after having lived and done many wonderful things to challenge his admiration, which he with all his inventive power and boasted reason has failed to duplicate or even successfully imitate. But who has analyzed instinct, or what writer or thinker has defined the line of demarkation between instinct, and reason or has said where the one ends and the other begins. A distinguished mental philosopher has told us "the will is the fulcrum, the prop, and the whole moving power of the intellect. Upon this and other as good authority we maintain that all organisms, from the animalcule to man and in common with him, have more or less will power which demonstrates the claim of all animal life to a portion, great or small, of mind. The diminutive insect, before it raises its tiny wings at the approach of danger and flies away, must first will to do this voluntary act. The lowest order of animal life that moves and sustains existence and carries out the objects of their being could do none of these things without exercising some will power.

All animal life has the will power necessary for more or less self-preservation and the perpetuation of their kind, which proves them in possession of some mind and an emanation from the great source and fountain of mind and as eternal as its source. Nor does it matter whether we find mind in the ponderous brains of a Webster or a Cuvier or in the scarcely perceptible nervous centre of the lowest order of organism, it is mind according to all rules of logic, and only differs in quantity or degree. What then becomes of this vast amount of mind when the frail and ephemeral tenements that hold them decay? The indestructibility of mind is an axiomatic truth, therefore it must exist in some form somewhere. Does it return to its author to be implanted in a new and improved form and returned to its former home and rise by gradual progression? Does it take its flight in obedience to some occult law through space to another portion of the physical Universe which the great moral force has prepared, an improvement upon this for the culture, education and expansion of these infinitesimal portions of mind to remain in a state of tutelage, improving and expanding for a higher state of existence when he will again transplant it to a still higher sphere and thus educate it up by regular gradation until it shall have attained the intellectual and moral power of the "four beasts in and around the throne worshiping the lamb." Or, is it started at once in its feeble and imperfect condition on a career in the great eternity of the future?

These are questions that do not belong to the domain of reason or philosophy; nor has revealed revelation thrown any light upon them, and the revelations of advanced science have as yet failed to make them clear.

It is no part of our purpose in this paper or those that may follow to antagonize true Christianity as it came from the great Teacher and his immediate followers, as we regard true and undefiled Christianity as the grandest civilizer of man the world ever saw, and the man who would pull down this form of religion is an enemy of his race.

Man has ever been a worshiping animal, and some form of religion dates away beyond the historic period, until it is lost in the mists of fable. We find some form of religion known and practiced, and it is destined to continuity the close of time in some form. There is not and has not been a form so likely to survive, as the Christian religion, which for nearly twenty one centuries has withstood the rude shock of its professed enemies and the still ruder shock of its pretended friends.

Most of the various religions that have prevailed in the world have been made up of priest-craft, idolatry, heathen mythology, superstition, error and brute force with little or no admixture of truth and have existed upon the ignorance and credulity of the uneducated masses they have oppressed and impoverished.

When Christianity dawned a new era was rapidly approaching and could it have remained in its purity as Christ and his apostles left it, would it not have filled the whole earth. But as early as the days of Constantine, courtly favor, office and thrift, as reward, followed a profession of Christianity, and multiplied thousands flocked to the church, most of whom had never been touched by the spirit of the Master, nor is it much better to-day. Priest craft, the traditions of churches, some heathen mythology, a large amount of superstition and error has crept into the Christian churches and is multiplying infidelity to an extent beyond the grandest efforts of the most deadly professed enemies of the true faith. A large proportion of the best cultured intellect of the world is now combating these departures from the faith in its purity. When this is accomplished, which is an herculean task, the world will be better.

BOOK NOTICES.

THE CURRENTS AND TEMPERATURES OF BERING SEA. Wm. H. Dall, Quarto, pp. 46, Illustrated, Washington, 1882. Government Printing Office.

This is Appendix No. 16 to the Report of the United States Coast and Geodetic Survey for 1880, and is the result of the personal work of Mr. Dall, who has been for several years an energetic worker and observer in various fields of research on the Pacific Coast. After giving tabular and classified records of temperatures, in winter and summer, of the Bering Sea and the course, rate of flow and temperature of the Kuro Siwo or Japanese Stream with voluminous extracts from the log books of numerous whalers and exploring vessels, he arrives at the follow-

ing conclusions, which will be found at variance with the heretofore accepted views regarding the Kuro Siwo:

"The Kuro Siwo compared with the Gulf Stream is cooler, has a much smaller volume, and is subject to serious fluctuations, which appear to be due to the monsoons.

"The Kuro Siwo sends no recognizable branch northward, between the Aleutians and Kamchatka, nor from any other direction into Bering Sea.

"The chief current of Bering Sea is a motion of cold water southward. This has a superficial stratum above it, which has, in summer when not interrupted by winds, a northerly motion of translation, but it is not sufficient, either in mass, motion, or consistency of direction, to be entitled to take rank as an ocean current.

"The surface currents of Bering Sea are formed by or chiefly dependent on tides, winds, river flows, the southerly motion of cold water, the distribution of floating ice, and the northerly motion of slightly warmer surface water, which are effective about in the order named.

"No warm current from Bering Sea enters Bering Strait, with the exception of water from the neighboring rivers or the adjacent sounds. This water owes its heat directly to the local action of the Sun's rays.

"The Strait is incapable of carrying a current of warm water of sufficient magnitude to have any marked effect on the condition of the Polar basin just north of it.

"The currents through the State are cool and chiefly tidal, but with a preponderating tendency northward, as before fully set forth.

"The currents in the Arctic, north of the Straits, are largely dependent on the winds, but have tendencies in certain recognized directions. Nothing in our knowledge of them offers any hope of an easier passage toward the Pole, or, in general, northward through their agency. Nothing yet revealed in the investigation of the subject in the least tends to support the widely spread but unphilosophical notion that in any part of the Polar Sea we may look for large areas free from ice."

PUBLICATIONS OF THE WASHBURN OBSERVATORY OF THE UNIVERSITY OF WISCONSIN. Vol. I, octavo, pp. 180, Madison, Wis., 1882.

This report is made by Professor E. S. Holden, who was selected to fill the vacancy caused by the death of the lamented Prof. J. C. Watson, and covers the period of time from the erection of the Observatory by Hon. C. C. Washburn, to the 30th day of September, 1881.

It comprises a description of the building and instruments, with catalogues of stars, new nebulæ, new double stars, red stars, etc., discovered or observed and reduced under the direction of Professor Watson by Mr. G. C. Comstock and Mr. L. W. Burnham. The latter has as usual devoted himself to the discovery and observation of double stars. A very valuable and interesting chapter

is that upon the great comet of 1881, which is illustrated by twelve drawings. The observations were made by Prof. Holden with the fifteen and a half inch equatorial and the zone eyepiece. Reports of observations of meteors, auroras boreales, the transit of Mercury, etc., are also given.

The State of Wisconsin is greatly indebted to Governor Washburn for the magnificent gift of this Observatory with its valuable instruments and equipments, and doubtless the work done in it will perpetuate his name far into the future of scientific progress as well as add increased lustre to the fame of Professor Holden.

KNIGHT'S NEW MECHANICAL DICTIONARY. Section II., Octavo, pp. 240; Edward H. Knight, A M., LL.D., Boston, 1882. Houghton, Mifflin & Co., $2.00.

This is Part II of the work so fully noticed in the August REVIEW. It commences with Cutting Machines and ends with Hydraulic Force-Pumps and Jacks, giving minute descriptions and illustrations of thousands of machines, instruments and processes.

To give an idea of the extent and accuracy of the information furnished we will say that about twenty pages are devoted to electrical subjects, including the electrical diapason, electrical machines, battery, cable, candle, clock, furnace, lights and lamps of every description, writing apparatus, telephone, motor, etc. Explosives are fully treated, also fire-engines, fireless locomotives, fuel, galvanic apparatus; gas and gas machines to the extent of nearly twenty pages; governors of all kinds, grain separators, hand machines, heaters, horse-powers, hot-air engines, hydraulic machinery, etc. In nearly all cases references to articles upon the different subjects are given. This important and valuable work is to be completed in four volumes at $2.00 each.

SLIGHT AILMENTS. By Lionel S. Beale, M D., F.R.S., octavo, pp. 283, cloth, Philadelphia; P. Blakiston, Son & Co. 1882. For sale by M. H. Dickinson, $1.25.

In this work the common diseases known as slight ailments, such as Indigestion, Constipation, Biliousness, Sick-Headache, Neuralgia, Colds, Sore Throat, Diarrhœa, etc., are taken up, their nature explained and proper treatment suggested. Professor Beale's long experience as a practitioner and teacher enables him to handle such subjects in an easy and popular manner, and at the same time to keep within strictly professional bounds. The work is in its second edition already and cannot be excelled in usefulness as a family guide for the management of any of the milder diseases such as are referred to above.

OTHER PUBLICATIONS RECEIVED.

Six Lectures on Light, by Prof. John Tyndall, F.R.S., in *Humboldt Library*, Vol. II, No. 37, 15c.; Sketch of Hon. Lewis H. Morgan, by F. W. Putnam, pp. 7; Semi-Annual Report of the Comptroller of the City of Kansas for the six months ending June 30, 1882, by N. Grant, Comptroller; Advocacy of the Proposed Amendment to the Constitution of Missouri concerning the Judicial Department; The *American Journal of Forestry*, Vol. I, No. 1, monthly, devoted to the interests of Forest Tree-Planting, etc., edited by Franklin B. Hough, Ph. D., Washington, D. C., $3 per annum; The *Collector*, a monthly journal devoted to Natural History, etc., edited by Charles and James Keyes, Des Moines, Iowa, 50c per annum; The *Epitome*, a monthly Medical Journal, edited by C. F. Kirk, M. D., Meridian, Miss., $2.00 per annum; Signal Service Notes, No. III, to Foretell Frost, by Lieut. James Allen, U. S. A., Washington, D. C., 1882; Drunkenness a Vice, Not a Disease, by Rev. John E. Todd, Hartford Conn.; Taylor's Freezing Microtome, by Thomas Taylor, M. D., Microscopist Agricultural Department, Washington, D. C.

SCIENTIFIC MISCELLANY.

SOME RECENT IMPROVEMENTS IN THE MECHANIC ARTS.

BY F. B. BROCK, WASHINGTON, D. C.

MECHANICAL TELEPHONE EXCHANGE.—In this novel system of mechanical telephone lines, a series of telephones, which are severally connected with the several conveying line-wires, are employed. Means are provided for connecting therewith an extension-line, and a angle-hanger located centrally with relation to said conveying lines and their attached telephones. Two branch lines are arranged to connect any two of the telephones through the angle-hanger. These branch wires can be attached and detached from any of the telephone line termini, and thereby form a circuit with any two of the lines.

ARTIFICIAL FUEL.—A late invention consists of artificial fuel made out of cut straw, chaff or hay, and residuum of petroleum, combined with peat, turf, or other like material molded by pressure into suitable blocks.

PRESERVATION OF WOOD.—A recent German invention consists of a process for preserving wood, which contemplates exposing timber to a current of steam under pressure; then removing the moisture by the production of a vacuum

marked on a barometer about equal to a column of mercury of twenty-seven cubic centimeters; then introducing a solution of sulphate of zinc under pressure until the wood is saturated therewith and removing the same by a vacuum; and, lastly, introducing a dilute solution of calcium chloride.

RAILROAD SIGNAL.—In this improvement the rotating shaft of the signal operates the gong or bell, and is driven through a spring treadle actuated by the flanges of the wheels of the coming train. This spring treadle carries a panel, which acts upon a ratchet-wheel on a shaft, which is geared to other shafts extending to the signal device.

HYDRAULIC ELEVATOR.—A hydraulic elevator is the subject of a recent invention. It consists of a moveable car or platform and apparatus for raising and lowering the same by means of hydraulic pressure acting in a cylinder upon a piston. A starting and stopping apparatus is combined therewith, controlled by the operator and constructed so as to automatically start the car with a fixed acceleration and to stop the car with a fixed retardation, independently of the speed at which the controlling mechanism is worked by the operator.

THE COMET.

T. BERRY SMITH.

O wanderer, from where dost thou come to my sight,
And whither art going so radiantly robed?
Hast been to the uttermost limits of night,
And far into Nature's deep mysteries probed?

No answer! No speech! O mysterious thing,
That burneth thy torch in the heavenly spans!
Far from me my boasting of wisdom I fling;
And bowing I bury my face in my hands.

EDITORIAL NOTES.

WE have received quite a number of pleasant letters and editorial compliments upon the October REVIEW, which was almost entirely given up to our report of the Montreal meeting of the American Association for the Advancement of Science. This is very gratifying, as the writing, condensing and arranging the matter for publication required an expenditure of personal labor and time that, coming upon us in the midst of the most busy month we have ever had in the course of a very busy life, was only to be made by sacrificing many hours badly needed for rest. To this latter fact must be ascribed some errors and omissions that appear in the report.

PROF. J. W. SPENCER, M. A., Ph. D., F.R.S., late of King's University College, Windsor, Nova Scotia, has been called to

and accepted the chair of Geology and Mineralogy at the University of Missouri. He also has charge of the branches of Palæontology and Zoölogy.

THE railroad companies interested in protecting the north bank of the Missouri River above and opposite this city are taking advantage of the unusually favorable fall weather and low water to riprap it along their lines. The Government engineers, into whose hands the application of the extremely liberal Congressional appropriation for this purpose has been placed, have commenced a preliminary inspection of the task before them and it is hoped that a good use will be made of the money before the high water of next spring shall again undo their work and possibly cut a channel across the isthmus back of Harlem and leave an island in front of Kansas City. Prompt and efficient work, such as is amply provided for in the appropriation, can prevent this, but it is highly probable that nothing else can. It is a serious matter with this city and if anything can be done to expedite action by the Government officials it should be attended to at once.

MR. W. H. CORY, of Philadelphia, has patented a process for the utilization of coal dust and slack by converting it into artificial fuel. This has been attempted many times but has ordinarily failed from the fact that the cost of the process exceeded the value of the manufactured article. Mr. Cory, however, claims, since his process is a cold one, that there is an enormous saving of labor, material and expense as compared with the pitch processes, in which the coal and pitch have to be heated. He also claims an advantage on account of the facility of his product for stowage, its cleanliness, hardness and portability; also as the only process known that will effectually hold together culm, lignite and the non-coking coals during combustion. An efficient and economical process for this purpose is a great desideratum to all class of consumers and a suitable machine would undoubtedly meet with an extensive sale in the west.

IT seems that in our abstract of Prof. H. C. Bolton's paper read at Montreal we misapprehended the scope of his proposed Index of Chemical Literature. He only invites the co-operation of chemists in compiling special indexes of the literature of the various chemical elements on some uniform plan, similar to those on manganese and ozone, already published. At a meeting of the Chemical Section of the A. A. A. S., held August 25th, a Committee was appointed "to devise and inaugurate a plan for the proper indexing of the literature of the chemical elements, to have full power to secure the co-operation of volunteers, and to report at the meeting of the Chemical Section in 1883." The Committee consisted of Dr. H. C. Bolton, Hartford, Chairman, Prof. Ira Remsen, Baltimore, Prof. F. W. Clarke, Cincinnati, Prof. A. R. Leeds, Hoboken, Dr. A. A. Julien, New York.

MR. F. W. VOERDE, formerly of this city, is now here putting Singer's Elevator Safety Stops upon the elevators of some of the best mercantile houses in the city. The device is extremely simple and effective, and, in view of the numerous elevator accidents that have occurred here lately, it would seem advisable for every person interested in this direction to investigate it carefully at once.

WORK is actively going forward at the new National Museum, and a large force of men is very busy in arranging the natural history collections, removed from the lower floor of the Smithsonian Institution and in opening boxes of collections which have been kept in store, some of them for years, simply because there was no space for exhibing them in the old building.

PROF. H. S. PRITCHETT, of Washington University, says in a recent letter, inclosing a remittance, "I feel a great interest in the success of the REVIEW and recognize very fully the service you are doing for science in the western country, and appreciate to some extent, at least, the difficulties of the position."

THE action of Dr. John Fee, City Physician, in attempting to inaugurate a system of interchange of views and co-operation between the medical officers of the various cities of the west for the prevention and management of pestilential and contagious diseases is highly commendable. The National Board of Health should have its powers and duties enlarged, so as to have direction and control of sanitary matters of all kinds instead of being limited to yellow-fever, cholera and small-pox.

PROF. C. D. ABBEY, of Wausau, Wis., in sending his annual subscription to the REVIEW, pleasantly says: "I consider the REVIEW a valuable periodical. In fact few are of more use to me and I am a subscriber for a large number. I must read and must read the best."

THE Surgeons-General of the army and navy have made a report to Secretary Lincoln, recommending a plat of five acres in the southwest corner of Hot Springs Mountain as a site for the proposed army and navy hospital, for the construction of which $800,000 was appropriated at the last session of Congress.

THE Directors of the National Mineral and Industrial Exposition, to be held in Nashville, commencing the first Wednesday in September, 1883, have organized, with a capital of $300,000. The exposition will embrace displays in every branch of industry in the Union, as well as minerals and timbers. It is also designed to include those from Mexico, South America and the West Indies.

ITEMS FROM PERIODICALS.

AMONG the original articles in *Van Nostrand's Engineering Magazine* for November, is one upon "House Drainage and Sanitary Plumbing," by Wm. Paul Gerhard, of Newport, R. I., formerly connected with the City Engineer's Office at St. Louis. Among the selected articles we find a very interesting Report on the Incandescent Lamps exhibited at the International Exposition of Electricity at Paris, in 1881, also an article upon "Sewer-Gas as a Factor in the spread of Epidemic Diseases, and on the Direction and Force of Air Currents in Sewers," and a valuable one upon "The Durability of Building Stones."

AMONG the practical articles in the *North American Review* for November is one by Judge Joseph Neilson upon "Disorder in Court Rooms" that may be read with profit by lawyers and judges all over the country; "A Problem for Sociologists," by Dr. Wm. A. Hammond; "Safety in Theatres," by Steele Mackay, and one on "Suppression of Vice," by Anthony Comstock, Rev. O. B. Frothingham and Dr. J. W. Buckley.

THE *Popular Science Monthly* for November gives an illustrated account of a phenomenon which has never before been observed —that of a snake, having crawled in between the bark and wood of a tree and died there, becoming lignified, or changed into wood, in the same manner as animals become fossilized, *i. e.*, the cells and fibres of the wood have actually taken the place of the organic parts of the reptile and left it perfect in shape, size and all other details, even to the eye-cavities, scales, etc.

MR. J. W. HEISS, telegraph operator at Watrous, N. M., has invented a modification of the telephone which he calls the Vibraphone. From a description of this invention given in the Las Vegas *Daily Optic*, it appears to be more simple and is claimed to be fully as effective as the telephone itself.

NUMBER 7, Vol. IX of the *Art Interchange*, published at New York City by Messrs. Turnure & Whitlock, has been received. It is called "a household journal," but it is nevertheless admirably adapted to the wants of amateur artists as a guide and a former of correct taste. Its editorials are original, sensible and practical, as well as appropriate, in view of its objects. Its illustrations are artistic and well executed and its general make-up is tasteful and elegant. Fortnightly; $2.00 per annum.

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